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PUBLIC WORKS.

CITY COUNTY STATE

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Paving Streets and Alleys in Dayton

Analysis of unit prices for most common types of street paving shows prices this year five to thirty per cent. higher than last. Specifications and unit prices of each. Plan followed in assessing costs.

By Ivan E. Houk *

More streets and alleys are being paved in Dayton, Ohio, this year than during any year since 1917. Contracts for thirty-four separate jobs, many of which are now completed, have been awarded since January 1. These contracts involve a total area of street paving of 70,185 square yards, at a contract cost of $326,094, of which $30,059 is for the necessary storm sewer work; and 11,905 square yards of reinforced concrete alley paving at a total contract cost of $33,593. In some instances the storm sewers had been installed by the city, by direct employment of labor and direct purchase of supplies and materials, before the paving work was advertised. Legislation is pending for fully that much more work, some of which will be advertised and completed yet this season; and petitions are on file asking for many additional street and alley improvements which we have not, thus far, been able to design owing to the pressure of the construction work. We expect to get these plans worked out during the coming winter so that the legislation can be completed early next year, in time for the work to be done in the summer and fall.

*City Engineer of Dayton, Ohio.

PAVEMENT TYPES

Practically all types of pavements have been laid in Dayton, from cobblestones to granite durax and from sheet asphalt to wood block. However, since there are several brick plants within a comparatively short radius of the city, the brick surfaces naturally predominate. On January 1, 1923, there were 59.34 miles of brick pavements within the corporate limits, 21.66 miles of sheet asphalt, 5.25 miles of wood block, 3.65 miles of concrete, 2.55 miles of granite block and granite durax, 0.37 miles of Medina stone,

LAYING BRICK IN CAR TRACK AND KENTUCKY ROCK ASPHALT ON THE SHOULDERS.
A ¼ inch by 8 inch steel plate is used as a header 18 inches outside the rail.

SAND FOR BRICK PAVEMENT DRYING IN PILES BEFORE BEING MIXED WITH CEMENT FOR CUSHION.

3.24 miles of bituminous macadam, and 2.74 miles of water bound macadam, all figures exclusive of alleys. This season we are laying brick, sheet asphalt, Kentucky rock asphalt, renapped Medina, and concrete; but no wood block, granite block, or durax, since we have no streets under improvement where such types were considered most economical. Practically all of our alley pavements are concrete, although there are a few brick alleys in the downtown section, and a few in the residential districts where hillside brick was laid because of the comparatively steep slopes.

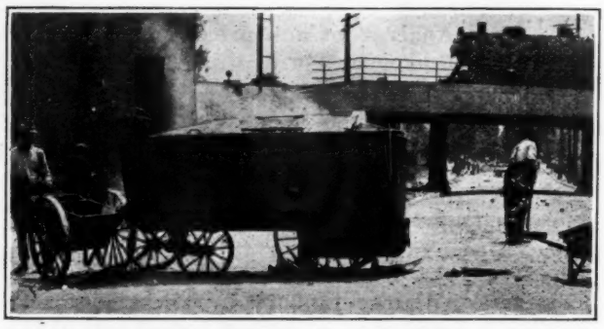
Brick is our general type of construction for car tracks, although we sometimes use durax, renapped Medina, or granite block. When wood block is laid on the shoulders it is either laid up to the rail or up to a suitable header built 18 inches outside the outer rails. On South Main street, which was paved last year, a 6-inch by 18-inch, 1-2-4 concrete header was used. On Brandt street, which has just been completed, and where Kentucky rock asphalt was laid on the shoulders and brick in the car tracks, ¼-inch by 8-inch steel plates were used as a header, placing them 18 inches outside the rails, fastening them to the concrete base by bolts laid horizontally into the concrete, and paving the spaces between the plates and the rails with brick.

PAVEMENT SECTIONS

Our sheet asphalt, Kentucky rock asphalt, wood block, brick, and other types of block pavements, are laid on a 6-inch, 1-3-6 concrete base, using, in the case of the block pavements, either a ½-inch, 1:4 cement mortar cushion, or a 1-inch sand cushion, the former being always used in the wood block construction. A soft filler is used altogether, either a straight pitch or asphalt, or a mastic made by mixing hot pitch or asphalt with equal portions of heated sand. The mastic filler costs slightly more than the straight pitch or asphalt, owing to the extra work involved in heating the sand and mixing the ingredients but is more satisfactory in the case of the stone block pavements where the joints are wide and irregular.

Our specifications call for wood block 3½ inches deep, either 3 or 4 inches wide, and from 6 to 10 inches long with an average length of 8 inches. Two kinds of oil are specified; oil "A," a distillate oil obtained wholly from coal tar, and oil "B," a more volatile oil produced from coal gas or coke oven tar, of which at least 65 per cent must be obtained by distillation. Standard paving brick, 8½ by 3½ by 4 inches in size, are used; either wire cut or repressed and with or without lugs, laying them with a 4-inch depth in most cases. Kentucky rock asphalt surfaces are laid 2 inches deep; and sheet asphalt, 3 inches. While our specifications call for a 1-inch binder and a 2-inch wearing course, in the case of sheet asphalt, we frequently use a 1½-inch binder and a 1½-inch wearing course.

Concrete alley pavements have a uniform thickness of 6 inches, are built with a concrete mix of 1-2-3, and are reinforced with a wire mesh reinforcement having a weight of not less than 28



POURING ASPHALT FILLER ON BRICK PAVEMENT. Littleford Heater, 7-drum capacity, used.

pounds per 100 square feet. The sides of the alleys are made 4 inches higher than the center so that the water will drain down the center. Concrete streets also are built with a 1-2-3 mix, and are reinforced with the same type of mesh used in the alleys. However, the streets, which have been from 25 to 30 feet wide, have a 3-inch crown in the center, so as to throw the water to the curbs. The slabs are made 5 inches thick at the curbs, and 8 inches in the middle of the roadway. At a point one-fourth the distance from the curb to the center, the thickness is 6⅛ inches; and at a point halfway to the center, the thickness is 7 inches. Transverse, built up expansion joints, from ¼ to ⅜ of an inch thick, are placed at 30-foot intervals in the case of alleys, and at 50-foot intervals in the case of streets. Similar expansion joints, ½-inch thick, are placed along both curbs in the case of streets. Screened and washed materials are used in the concrete bases for other types of pavements as well as in the concrete streets and alleys.

We have not thus far changed our slab design as a result of the Bates Road tests, because the conditions on the residence streets where we have been using concrete are different from those existing on rural highways—as regards traffic as well as construction. In the case of city streets the roadways are wider, the edges of the pavements are protected by curbs, the foundations are more uniform and better drained; and, moreover, the traffic does not follow the edges closely as it does on country roads, primarily because of the parking along the curbs. Consequently it does not seem proper to make city pavements thicker at the edges than in the center. We have not as yet used concrete on streets which are subjcted to heavy traffic. If we should in the

Low Unit Prices Bid on Dayton Street Paving Work During 1923

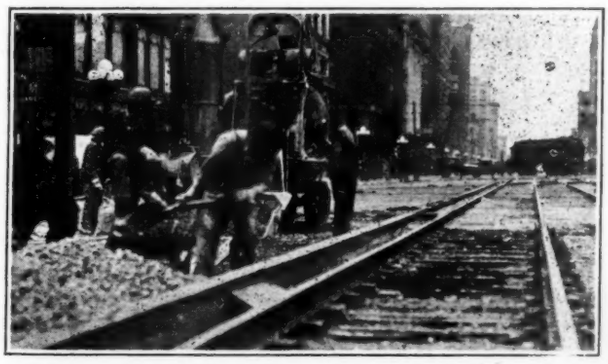
Street	Cu. Yds.	Sq. Yds.	Price per Square Yard Laid: Conc.	Ky. Rock	Sh. Asph.	Brick	Med. Block	Wood Blck.	Gran. Blck	Sewer Cost	Total Cost	Remarks
Brandt	...	8,375	...	...	...	$3.75	...	...	...	...	...	Sand cushion, asphalt filler.
	...	6,755	...	$2.67*	...	4.00*	...	...	...	$237	$27,912	2" Ky. rock on shoulders, brick in car tracks, sand cush., asphalt filler.
	...	6 755	...	2.47	...	4.00	...	...	...	...	...	1½" Ky. rock on shoulders.
Delaware	6,450	4,500	$2.90	...	...	...	...	...	...	5.061	23,357	Standard section.
Dow	4,000	2,300	3.09*	3.41	$3.80	4.10	...	...	...	3,064	13,091	Std. conc. sec., 2" Ky. rock sand cushion, asph. filler for brick.
Fairview	...	5,830	...	...	...	4.10*	...	...	...	946	28,857	Sand cush., asphalt filler.
Grafton	...	4.525	...	...	...	3.89*	...	...	...	1,362	19.390	Sand cush., asphalt filler.
Irwin	...	5,025	...	...	...	3.81*	...	...	...	550	22,148	Sand cush., asphalt filler.
Lefever	4,000	2,000	3.71	3.94*	4.75	...	...	...	...	465	9,794	Std. conc. sec., 2" Ky. rock, 3" Trin.
Main St. Bridge	...	2.650	...	...	...	...	4.94*	...	$7.94	...	14,531	Mortar cush'n, asphalt fill'r
Negley Place	675	1,500	2.30*	...	...	...	...	...	...	155	4.740	Std. sec.
Red Haw Road	2,900	2,250	2.94	3.54*	3.75	...	...	...	...	2,331	13,177	Std. conc. sec., 2" Ky. rock, 3" Trin.
Richmond	7,700	11,550	3.10	3.29	3.45*	4.46	...	$5.00	...	3,527	50,637	Std. conc. sec., 2" Ky. rock, 3" Trin., oil A, mortar cush., asph. filler.
Rosemont	2,100	1,550	2.90*	...	...	...	...	...	...	368	5,823	Std. sec.
Summit	...	10,575	...	...	...	3.99*	...	...	...	7,573	54,019	Sand cush., asphalt filler.
Western	...	6,130	3.13	2.91	3.65	3.97*	...	...	...	3,985	31,179	8" conc., 1½" Ky rock, 3" sh. asph. 3½" brick, sand cushion, asphalt filler.
Mt. Vernon	1,090	1,425	2.94	3.54*	3.75	...	...	...	...	435	7,439	Std. conc. sec., 2" Ky. rock, 3" Trin.

Total area under contract—70,185 square yards. Total contract cost—$326,094. Total sewer cost—30,059.
*Contract awarded on this basis.

future, I am inclined to believe that we should use a somewhat heavier cross section, possibly a slab with a uniform thickness of 8 or 9 inches, reinforced with bars instead of mesh.

UNIT COSTS

The accompanying table gives the low prices bid on the various street paving contracts awarded thus far this year. It will be noticed that alternate plans were provided in nearly all instances. Our general policy is to take bids on several different types of pavements, whenever such types are suited to the particular conditions, in order to secure competition



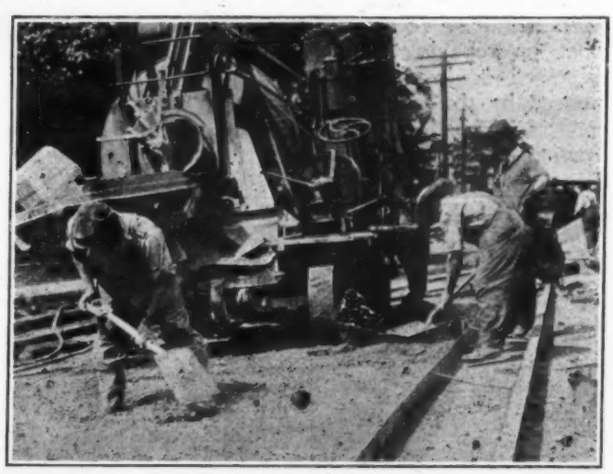
CONCRETE HEADERS BETWEEN WOOD BLOCK ON THE SHOULDERS AND BRICK NEXT TO TRACK.

among the material men as well as among the contractors. After the bids have been opened, read, and tabulated, the final decision as to type of surface is made, and the contract awarded to the low bidder on that type. While we are not required by law to award the contract to the low bidder, we have done so during the last two years, except in cases where the low bid was irregular for some reason. In such instances we have readvertised the work.

The type of surface on which the award was made in each contract is indicated in the table by an asterisk following the price on that particular surface. The table also gives, for each job, the area involved in the improvement, the amount of grading, the total contract cost of the sewer work included, the total amount of the contract, and general remarks regarding the type of cushion, filler, depth of wearing course, and so forth. The prices bid for the paving cover the grading but do not include curb. Where no yardage is indicated the grading included simply the excavation necessary to make room for the pavement.

It will be noticed that the bids varied from $3.75 to $4.46 per square yard in the case of brick, from $3.45 to $4.75 per square yard in the case of sheet asphalt, from $2.67 to $3.94, in the case of Kentucky rock asphalt, from $2.30 to $3.71 in the case of concrete; and that a bid of $4.94 per square yard was obtained on the renapped Medina stone, a bid of $5.00 per square yard on wood block, and a bid of $7.94 per square yard on granite block. These prices are from 5 to 30 per cent higher than the low bids on similar jobs last year. Reinforced concrete alley pavements are costing from $2.25 to $2.90 per square yard this year, as against $2.09 to $2.50 last year.

In the case of the brick pavements, where bids were frequently received on both types of cushion, the mortar cushion bids were generally from 10 ro



LAYING BASE FOR ROCK ASPHALT SURFACE.
One-bag Foote mixer used. Shows steel plate header between asphalt and brick surfaces.

20 cents per square yard higher than the sand cushion bids. Wood block bids on the basis of oil "A" have generally been from 10 to 20 cents per square yard higher than bids on the basis of oil "B." Bids on Trinidad asphalt have been about 10 cents per square yard higher than bids on oil asphalt.

Concrete combined curb and gutter, 12 inches deep at the back, 6 inches thick, with a 15-inch gutter, is costing from 70 to 90 cents per lineal foot for the straight sections, and from 90 cents to $1.40 per lineal foot for the circular, prices which are about 10 per cent higher than last year. Concrete curb alone, 6 inches wide and 21 inches deep, is costing practically the same as the combined curb and gutter. Both types are built with a 1-2-4 mix, and are set on a 6-inch gravel foundation. Catch basins in place are costing from $35 to $55 each; inlets, from $15 to $20 each; and manholes, from $40 to $55, prices which are about the same as last year.

ASSESSMENTS

The Dayton Charter provides that "The city shall pay such part of the cost and expense of improvements for which special assessments are levied as the Commission deems just, which part shall not be less than one-fiftieth of all such cost and expense; and in addition thereto the city shall pay the cost of the intersections." The Charter also provides that special assessments upon property benefitted may be made in three ways, first, by a percentage of the tax value of the property assessed; second, in proportion to the benefits received; and third, by the foot frontage of the property abutting on the improvement. Consequently, the general practice in recent years has been for the city to pay the cost of paving the intersections and 2 per cent of the cost of paving the portions in front of private property. The remaining 98 per cent of the property portion is assessed either by the foot frontage or by benefits, generally by the former method. Property owners are given the opportunity of paying their assessments in cash. If not paid in 30 days the assessments are certified to the county, and collected, with the taxes, in nine annual installments.

Repaving costs have been assessed by the same methods in the past, but will be assessed differently in the future—exactly how is not yet definitely determined. A recent supreme court decision held that on repaving jobs only half the cost can be assessed against the abutting property. An act, passed by the Ohio Legislature at its last session, provides that on repaving projects the property owners must be rebated for half the original assessments, amounts which are, of course, much less than half the present cost.

EXCAVATING TO GRADE WITH A THEW SHOVEL AND ¾-YARD BUCKET.

In the case of Brandt street and Western avenue, which are connecting links between city thoroughfares and county pikes, and which are being handled by the county, the county pays one-third the cost, the city one-third, and the abutting property owners one-third; first deducting, in the case of Brandt street, the cost of the paving in the car tracks and 18 inches outside, which portion of the cost is assessed against the street car company.

Sewer and water connections are installed by the city, prior to the paving, if they have not been installed by the property owners after being ordered to do so. The costs of such installations, if not paid in 30 days after the bills are rendered, are certified to the county and collected with the taxes in one installment.

Thus far the city at large has paid the entire cost of all storm sewers, whether main drains or street laterals. While the city has the right to assess the cost of such improvements, the officials naturally hesitate to make such a radical change in procedure. To do so now would be placing an unfair burden on the people who have no storm sewer but who have, for years, been contributing to the cost of construction of such improvements in other parts of the city. However, such a change is being contemplated in the case of repaving work.

With the exception of the streets paved in cooperation with the county, the paving work in Dayton is handled by the Division of Engineering, one of the subdivisions of the Department of Public Works. George F. Baker is Director of Public Service and F. O. Eichelberger is City Manager. W. O. Pease, County Surveyor, has charge of the work handled by the county.

Stream Pollution in Virginia

Early in October Commissioner Lee of the Virginia Department of Game and Inland Fisheries called a conference of representatives from several towns to consider the obtaining of legislation for preventing the pollution of streams. An effort will be made to prevent pollution by factories in so far as this can be accomplished by preventing the establishing of new factories which would cause such pollution. It is not expected that the General Assembly will cause existing factories to shut down, but it is said that the proprietors of factories have shown a desire to do what they can in ameliorating the present conditions if this does not necessitate a heavy expenditure. It is possible that a commission will be appointed to study this matter.

Heavy Traffic in Chicago

Fifth Avenue, New York City, is frequently cited as an example of a heavy-traffic street and even as carrying the heaviest traffic in the country. However, it is reported that an actual count of traffic over the Michigan Avenue Link Bridge in Chicago shows it to exceed the Fifth Avenue traffic by nearly 50%, 53,014 vehicles having crossed this bridge between 7 A. M. and midnight, with a maximum of 4,360 during the rush hour.

Renewing a Sewage Treatment Plant

By W. A. Hardenbergh

Effluent of septic tank improved by insertion of baffles, and capacity of contact beds doubled by washing stone by means of home made apparatus.

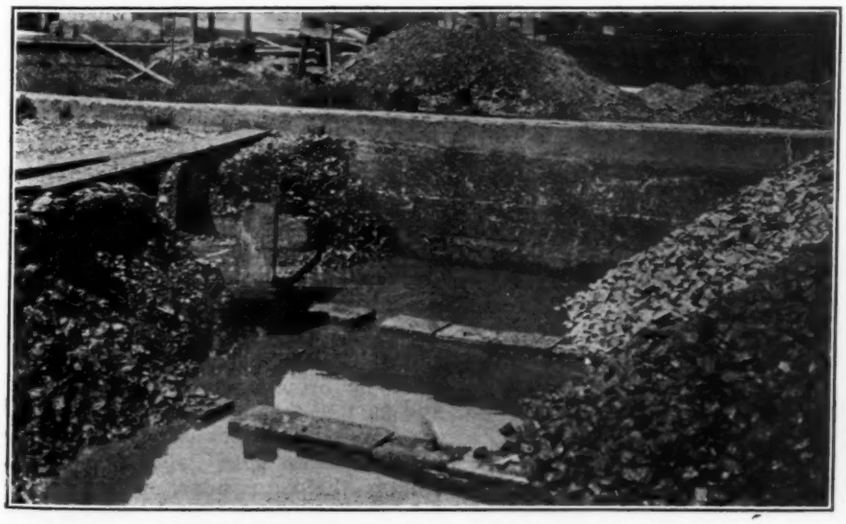
Liberty, N. Y., is served by a small sewage treatment plant consisting of two septic tanks, four contact beds, each 40 feet by 90 feet, and four strainer beds of fine cinders. The effluent is discharged into a fair-sized creek. A rather full description of the plant was given in MUNICIPAL JOURNAL, September 17, 1914.

The population of the village has been increasing steadily since the plant was constructed in 1898 (the plant was rebuilt in 1908, but not enlarged) and during the summer season—for Liberty is a popular summer resort—there are six or eight thousand people contributing sewage to the plant. The normal flow of sewage for nine months in the year is about 250,000 gallons a day; during the summer months this increases to about 350,000 gallons daily. The result has been a heavy overload on the plant, partly because it was not designed to treat so much sewage, and partly because maintenance has been neglected.

During the summer of 1922 the problem became so serious that the village secured an engineer to report upon it. An examination showed that baffles were lacking in the septic tanks, resulting in short-circuiting, that the contact beds were badly clogged and in need of cleaning and replacement, and that the strainer beds were being operated incorrectly and at too high a rate. Faced with an immediate problem, it was not possible at the time to make any permanent improvements, but an attendant was hired and the plant given careful full-time operating attention.

CONDITION OF STONE BEFORE CLEANING.

Among the temporary improvements was the adjustment of the contract and resting periods for the contact beds, resulting in a vastly improved effluent; the leveling, raking, and regular operation on schedule of the strainer beds; putrescibility and efficiency tests; and the keeping of proper records by a full-time operator. This carried the plant through the summer in fairly good shape, but it was recognized that work would have to be done to prepare the plant for the 1923 season.



STONE BEFORE AND AFTER CLEANING.
Shows underdrains and seepage water.

The village, during the winter, voted $7,000 for repairs to the plant upon the advice of the engineer. It was not considered necessary to build a new plant, but considerable repairs to and proper operation of the old plant was demanded. The repairs needed included the construction of baffles in the

GENERAL VIEW OF STONE WASHING PLANT.

tank, the rehabilitation of the contact beds, and possibly repairs to the strainer beds. Work was absolutely necessary on the contact beds, which were clogged beyond any usable stage. Septic tank effluent could not be discharged into the stream; the strainer beds would not handle the tank effluent without further clogging, and the effluent from them when handling tank effluent was not good. Washing or replacing of the stone in the beds, therefore, appeared to be necessary. Tests indicated that the voids in the contact beds averaged 12%; in some beds it was less.

The cost of suitable stone delivered at Liberty was $3 per yard, with an additional $2 a yard for hauling to the plant, and $1 for placing. Removal of the old stone was estimated to cost $1 a yard, a total cost of $7 a yard, or about $12,000, for the replacement of stone in all four beds. It was believed that it would be much cheaper to wash the old stone and replace it in the beds, and this was decided on.

A search of engineering literature did not yield much data on methods or costs of washing contact bed stone in such small quantities. Consequently it became necessary to devise methods for the work.

A second-hand, hand-power coal screen, 6 feet long and 2 feet in diameter was purchased for $40. A 1½-horsepower gasoline engine was rented to drive it. After an unsuccessful attempt to use the chain drive furnished with the screen, a belt was run from the engine pulley around the body of the screen, as shown in the illustration. This solved the problem, though later events proved a slightly larger engine would have been better. It was thought that water would have to be held in the screen in contact with the stone for a period of time to insure proper cleaning. To attain this, the first two of the three screen sections were lined with sheet iron, leaving only the last section open.

SCREEN USED FOR WASHING STONE.

Water under pressure was not available, so another gasoline engine was rented and connected to a small pump. This drew water from the creek and forced it under a fair pressure to the washing apparatus. A hose and nozzle made the water supply flexible.

It was decided to handle the stone by barrows and shovels. A platform, with runways, was built at the screen. Stone was dug out of the bed, taken in barrows to the screen, washed, and returned to another part of the bed, previously excavated. In this way, considerable extra handling of the stone was avoided. A stock-pile of about 50 yards was maintained.

The stone was forked into the screen, through which a stream of water was directed. The stone issued from the screen almost absolutely clean. The equipment gave little trouble, though the screen lining wore out and had to be replaced for each bed (400 cubic yards). The main difficulty was in getting stone to the screen. Forks were found superior to shovels for handling the stone, if a smooth bottom was available. When stone could be brought to the washer in sufficient quantity, 5 to 10 yards an hour could be washed, but in practice there were few days in which more than 35 yards of stone were handled. The average was less, with delays, being about 20 yards a day.

As shown in the illustrations, the stone was very dirty, but in good condition otherwise. The loss from disintegrated or too small stone was very small. When replaced after being washed, the stone appeared in all respects as good as new.

The cost of washing the stone ran over the estimate, but was much less than the cost of replacement. The first bed cost just about $1,000 to wash, or $2.50 a yard, which is about the average cost including overhead, gasoline, etc. The original estimate was $1.50 per yard. Labor proved very hard to get. In fact, it was impossible to keep enough men on the job to maintain the work at full speed. Trouble was also caused by water and sewage seeping into the beds, requiring that the men work in 6 to 8 inches of water at times. Cleaning of the subdrains, which were badly clogged, was another item of expense not contemplated in the original estimate.

Two beds and part of a third one were cleaned in May, after which the work was postponed until fall, mainly because of labor shortage. Work on washing the remainder of the stone was begun early in October, and is being carried on at the usual rate of 20 to 25 yards a day.

The results of the work on the beds cleaned last May have been extremely satisfactory, especially when coupled with the improvements to the septic tanks. The capacity of the contact beds was doubled by the washing, while the effluent from the septic tanks appears to be considerably improved. For the first time in years there was no mid-season problem at the Liberty plant. The only trouble occurred late in the season when a local creamery discharged several hundred gallons of milk plant wastes into the plant, temporarily putting it out of order and creating a considerable nuisance from odors.

In addition to the washing of the stone, additional baffles were constructed in the septic tanks, and provision made for mixing the effluent from the strainer beds more intimately with the creek water. The baffles were constructed of hollow tile, so placed as to utilize most effectively all the space in the tanks.

Labor for washing the stone was paid $5 and $6 a day of 9 hours, and the foreman $8 a day. Even with this wage scale in force, men were very difficult to get; the work was hard and disagreeable. Including lost time, from 15 to 20 working days were required to wash each bed.

The work was under charge of the Board of Sewer Commissioners of Liberty, Fred Grimm, Walter Randall and Harold O. Weyrauch. To the last is due much credit for planning the ingenious devices used on the work, and for the solution of difficulties which arose from time to time.

American Road Signs

Curious instances of misinformation concerning American affairs published in English papers occasionally come to our attention and we wonder where they obtain such items as the following:

"There are few towns or even villages in the United States which are not provided with signs giving not only the name thereof but affording other information of a useful character to visitors, and these are invariably constructed of concrete." The "invariably" looks like propaganda of the cement manufacturers. Our observation would lead us to consider even "occasionally" as highly flattering.

Business Street and White Way Lighting*

Facilitating traffic by night aids in remedying traffic congestion. Requirements of lighting for main and secondary business streets, as to density, color and distribution of light, and appearance of lighting units by day.

While the fundamental idea of street lighting is to aid in the prevention of accident and crime, it has a secondary value as an advertising medium for the city or town. Ornamental and high intensity lighting are found to have high advertising value for business streets. From small beginnings with temporary white way lighting for celebrations the idea has spread until now permanent installations are found in business sections of both large and small cities.

Such lighting affords a distinct gain in business efficiency by increasing the hours during which a safe and comfortable use of the streets is possible. In addition, bright light exercises a definite attraction for almost everyone. Specific instances could be cited where, when certain commercial streets only of a city have been equipped with brilliant lighting, they have gained in evening traffic over the poorly lighted ones in a ratio of 2:1 or even 3:1. There is the added advantage to the citizens that well lighted business streets permit those who are engaged during the day to do their shopping with comfort and pleasure during the evening hours.

By so lighting city streets as to permit night traffic of the same density, safety, speed and convenience as by day, and thus facilitate continuing traffic during more hours out of the 24, traffic congestion is greatly relieved, and the time when duplicate construction of streets or of pavements suitable for heavy traffic will be required is postponed for years in many cases, provided a large percentage of the traffic can be diverted from the crowded day hours. A well-known electrical expert has estimated that reductions in trucking cost as great as one-half would be possible by the increased utilization of equipment and terminal facilities and the avoidance of traffic delays, if streets were used by a large part of this traffic during the less congested night hours.

This subject of the lighting of business streets has been studied comprehensively by Earl A. Anderson and R. E. Greiner, illuminating experts, among others, and much of the material in this article is derived from their researches.

It is essential in considering a plan of street lighting to observe carefully the different requirements of each class of street to the end that the available money set aside for the purpose will do the greatest good. The business streets and thoroughfares will, of course, require the greatest amount of illumination, for in this section there is congestion of foot, vehicular and street-car traffic. The principal thoroughfares leading from the center of the city, and also the streets in the wholesale and manufacturing districts, carry much traffic of a high-speed nature and must be lighted accordingly.

*Published through the courtesy of the Electrical Industry's Joint Committee for Business Development.

STREET IN EAST CLEVELAND, OHIO.
1,000 c.p. lamps attached to 6-foot bracket arms 20 feet above the street; staggered, one lamp per 150 feet of street.

The highest intensity of illumination in the principal business streets of large cities at the present time is not greater than would be desirable for all streets of the city, were it not for the cost. But because of the very great areas to be covered and the very limited appropriations available, it may be impracticable to provide more than perhaps one-tenth as much light in the residential streets as in the principal business section.

STREET IN SEBRING, OHIO.
600 c.p. Mazda C lamps mounted 13½ feet high, spaced 90 feet.

LIGHTING BUSINESS DISTRICTS

As the commercial life of a community is centered in its retail business district, the illumination here should be of the highest order. It should provide: (1) A high density of illumination to attract the crowd, increase business and prevent accidents from dense traffic; (2) The most effective quality with regard to color, diffusion of light and freedom from glare; (3) A distribution so controlled as to give sufficient illumination on a street surface and at the same time allow sufficient light to strike the buildings and make visible the architectural details: (4) Units of such a character as to give an attractive appearance by both day and night and harmonize with the character of the buildings and carry out the traditions of the community.

A distinctive character of white way illumination is that more lighting is demanded between street intersections than on the corners themselves, whereas in all other classes of street lighting the maximum is required where the lines of traffic cross. The reason for this is that the decorative and publicity functions call for more light than would be required for reasonable safe travel.

For important business streets in cities, the most widely favored method of lighting consists in the use of single-light ornamental standards mounted at heights of from 14 to 25 feet and spaced opposite each other at distances of from 60 to 120 feet. For very narrow streets the lamps may be placed on one side only or staggered at the same spacing. An important increase in efficiency is secured by the use of lamps of 600, 1000, 1500 or 2500 candlepower instead of the three, four or five-light clusters using small lamps which were in vogue before the introduction of the high-powered, gas-filled incandescent lamp.

There is at present a very noticeable tendency to depart from the use of the opal ball or globe, and to use instead a lantern structure, which is considered by many to be more pleasing in appearance. Cleveland was the first large city to adopt equipment of this character and has many hundreds of most attractive standards using 1000 and 1500-candlepower lamps. These lanterns are glazed with a ripple glass and are used with prismatic refractors which increase the amount of light delivered to the street by turning downward the light rays which in an ordinary opal globe are largely lost.

Instead of the single-lamp standards spaced relatively close together, some cities have adopted standards carrying two or even three high-powered lamps mounted from 20 to 30 feet above the street and spaced from 150 to 200 feet apart. The resultant effective illumination is not greatly different from the more usual arrangement and the exceptionally high mountings minimize any possibility of glare from the lamps. On the other hand, there appears to be much weight on the side of those who contend that on business streets the surrounding brightness of buildings, show windows, etc., is such that there is no possibility of serious glare, even with the large lamp at the lower mounting of from 15 to 18 feet, and that the desirable white way effect is enhanced by lanterns at the lower heights spaced 80 or 90 feet apart.

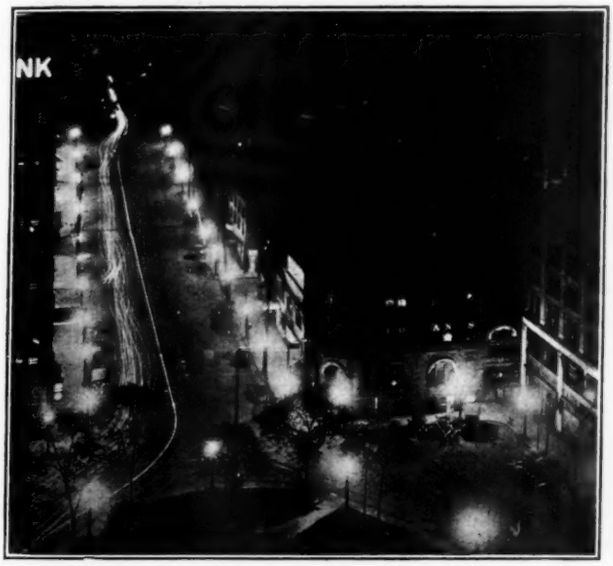
The demand for higher levels of illumination on business streets has led in some cities to the consideration of lamp standards carrying two or three 1000 or 1500-candlepower lamps each and spaced no more widely than previous single-lamp installations. It is quite possible that there will be an increased development of this tendency, especially in the larger cities where the crowds from evening business and amusements have become such that in many cities white way systems which were installed quite largely as an ornamental or advertising feature are even now barely adequate from the standpoint of lighting for safety.

SECONDARY BUSINESS STREETS

In each city there are less important business streets adjacent to the main business street, and those smaller business centers which spring up in

semi-suburban districts of all kinds. On these streets it is obvious that the intensity of illumination will be somewhat lower than on the streets of the principal business section. It should, however, be of a comparatively high standard. But there is not the same demand for the publicity element, and traffic is not likely to be so heavy on this type of street, making a slight decrease in illumination possible without increasing the number of accidents. There will still be provided ample illumination for the prevention of crime.

In general, the ornamental system used "downtown" should be continued on the secondary business



WHITE WAY LIGHTING IN YOUNGSTOWN, OHIO.
1,000 c.p. Mazda C lamps at 90-foot intervals.

streets to preserve the uniformity of appearance. It is, however, sometimes necessary to allow a somewhat wider spacing or smaller lamp, or to use a more economical method of lighting. In this case a pendent-type unit with diffusing globe would be recommended. Refracting equipment is generally desirable with either type, especially if the spacing is fairly wide.

Because of development of refracting equipment, the distribution of light from street lighting fixtures can be accurately controlled to give the maximum candlepower at any desired angle. This is ordinarily 10 to 15 degrees below the horizontal. The directional effort is secured by means of a prismatic glass refractor, the prisms being so designed as to refract the light given off by the lamp into the desired direction.

The buildings lining the secondary streets are not so high as those along the main business section and the streets are somewhat narrower. In mounting the units, if the ornamental type is used, the same style standards are employed as on the main business street with a wider spacing or a somewhat lower mounting height and smaller lamp. If the ornamental type of unit is used, 400, 600 or 1000-candlepower lamps should be employed, spaced 100 to 125 feet, and mounted at from 13 to 18 feet. If pendent units are employed, the lamp is mounted on a mast arm and swung over the street. In this case, the lamp sizes and spacings should be the same, but the mounting height should be from 15 to 20 feet.

Water Divining in England

We occasionally hear of instances in this country of the alleged location of underground water by the use of twigs of hazel or other trees in the hands of a "water diviner," but so far as we know this practice is not taken seriously by any educated people. However, in England, this use of water diviners or "dowsers," as they are called there, appears to receive even the official sanction of the highest authorities in the Government. Dozens of cases have been reported during the past year or two of the employment of dowsers by different English municipalities, one of the latest being the engagement by the town council of Chelmsford of two young ladies who are reputed to have inherited their water divining powers. One taxpayer who did not appear to be convinced of the reliability of this method of locating underground water inquired of the Minister of Health whether local authorities were authorized by the Government to invest public funds in water divination by dowsers, and was informed by the Minister that "reasonable expenditure" for this purpose was authorized by the health authorities.

STREET IN TOLEDO, OHIO.
300-watt Mazda C lamps in rippled globes, two to a pole, poles spaced 100 feet apart.

Sewage Pumping in Jacksonville

By W. E. Sheddan *

Six pumping stations lift sewage from several low and distant areas into the river. Enlarging pump well increased capacity of trunk sewer. Automatically controlled pumps installed.

Jacksonville, Florida, is fortunately located at a bend of the St. Johns river, which forms the boundary on two sides and provides adequate and comparatively simple means of disposal for the city's sewage. However, owing to the flat terrene, with comparatively low elevation, it is necessary to divide the system serving that portion of the city along the riverfront into numerous small outfalls. Many of these in time will have to be emptied into an intercepting sewer and carried out into deeper water, but it is doubtful if treatment methods will ever have to be resorted to.

The highest part of the city is only 37 feet above mean low water in the river, and this is a small area which is only about a quarter of a mile back from the river; whereas the larger areas back one and two miles from the river have an elevation ranging from 15 to 27 feet. To boost the sewage out into the river from these back areas requires six sewage pumping stations, ranging from a small station handling somewhat less than one-third of a million gallons of raw sewage daily, to one handling over two million gallons daily; this quantity being somewhat increased in wet weather due to seepage and a certain amount of roof drainage that gets into the system.

This last station handles sewage from a strictly residential section of the city comprising approximately 900 acres, about one-half of which contains a better class of residences—two to four-family houses—with a number of apartment houses scattered about; while the rest has been built up with a cheaper class of cottages housing a negro population. This area is provided with two trunk line sewers, one a double line of twelve-inch pipe extending eastward and northward, and the other a fourteen-inch trunk line extending to the westward and northward, the two forming somewhat of a "U" shaped trunk system with secondary trunk and laterals covering the territory, with the station located in the lower part of the "U."

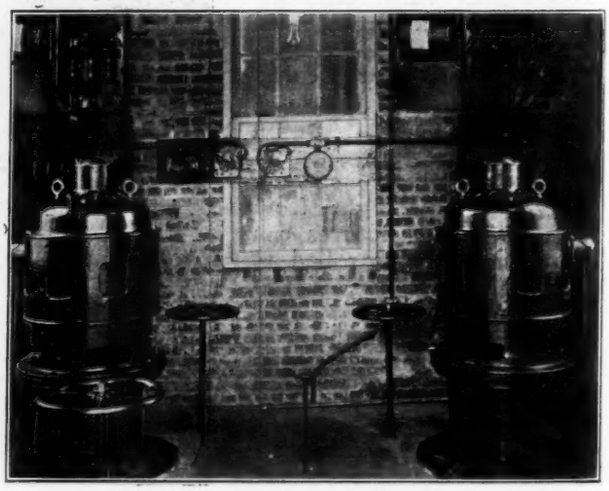
About four years ago this system began to show signs of distress from overload. Studies of the problem were started to determine the best way to relieve this condition. It was at first thought that it would be necessary to rebuild the westerly trunk line or provide a relief pipe line paralleling it, but as this would require a rather large expenditure of money, which was not to be had at that time, our studies reverted to the pumping station.

The old station comprised a receiving well, circular in shape, 30 feet in diameter and 12 feet in depth, the bottom being elevation minus 7.5′, all of the sewage emptying into this receiving well near its bottom. The pumping equipment comprised two 3,000-gallons per minute horizontal type centrifugal pumps, direct connected to 220 volt, three phase, 50 h.p. A. C. motors, discharging into a 14-inch force main, which carried the sewage over a rise emptying into an 18-inch gravity line, which carried the sewage about three-quarters of a mile by gravity into the river. The total head against which these pumps were working was, with the sewage low in the well, some 25 feet. These pumps were hand controlled and operated intermittently, the well being allowed to fill, which necessarily backed the sewage up in the entire system for a distance of one mile. This condition alone materially reduced the capacity of the system. Moreover, the size of the force main being so small, only one pump could be operated at a time. Both outfits were old and somewhat worn and were not at all adapted to meet conditions.

A study was made of the flow and quantities of sewage, over a period of weeks, readings being taken 24 hours each day. In this way the minimum and maximum rates of flow were fairly accurately determined, as well as the total quantities pumped each day during this period, which was fairly typical of normal conditions.

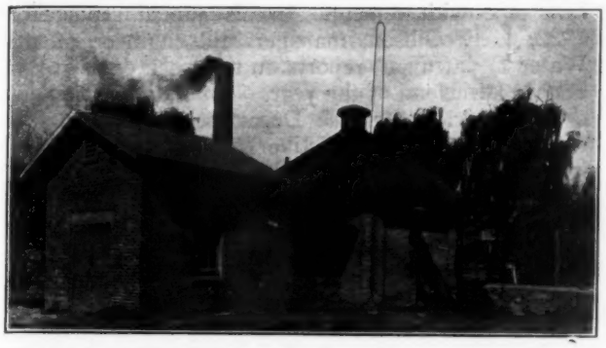
It was decided to construct a dry pit eight feet from the receiving well and place in it two bottom suction centrifugal pumps with 14-inch suctions to the well. Each pump is designed to pump 1,600 gallons per minute; they are direct connected to 25 h.p., three phase, 220 volt A. C. motors, and are equipped with automatic starters, phase controls, and are the most modern type. They have been in service for one year, giving entire satisfaction, and accomplishing the desired relief to the system.

In operating this station the float controls are so set as to keep the sewage at a low level in the receiving well; one of the pumps running practically all the time and the second pump cutting in over the peaks, when the flow is greater than one will handle. In this way we prevent the backing up of sewage in the system mentioned above, and, in our opinion, have increased the capacity some twenty per cent or more, and have actually shown a less current consumption,



INTERIOR OF PUMP HOUSE—MOTOR AND CONTROL SWITCHES.

*City Engineer of Jacksonville, Fla.



NEW SPRINGFIELD PUMP HOUSE OVER DRY PIT AND OLD PUMP HOUSE OVER RECEIVING WELL.

Smoke stack has no connection with station.

and have been able to discontinue the services of two pump operators at this station. The equipment in the old station has been left in place, and one outfit, reconditioned, is available for emergency use.

The dry pit and pump house were constructed by Benj. Thompson as contractor, at a cost of $2,005.18; pumping equipment was installed by Buford, Hall & Smith of Birmingham and Atlanta, at a cost of $4,587.00, the pumps being the "Yoeman's" make, with direct connected G. E. motors.

By installing automatic controlled, submerged type of pumps in our other five stations, one pump mechanic at $140 per month now easily cares for all six stations, where formerly it required the services of six operators at $90 per month each. This alone shows a material saving to the city, to say nothing of added efficiency, and the saving of worry and trouble from antiquated installations.

Lining Canals

Concrete 1.5 inches thick reduced seepage loss by 50 to 90 per cent., increased carrying capacity, and reduced cost of maintenance by 60 per cent.

For several years past the canals of the Orland irrigation project in California have been receiving a concrete lining, a little each year. The results obtained indicated decided economic advantages, which would apply to canals for water power or any other purposes.

The canals lined varied in bottom width from 3 feet to 15 feet and in vertical height from 1.5 to 4.75 feet, with side slopes of 1½:1 and 2:1. They were lined with concrete 1½ inches thick, the bottom and slope of course being first dressed to uniform surface.

During the season of 1922-1923, 77,919 square yards of lining were placed, the length of the canal being 9.05 miles. This required 2,883 cubic yards of concrete. The costs averaged 39.5c per square yard for lining or $10.70 per cubic yard of concrete. The unit costs per square yard averaged as follows: Preparing section for lining, 7.6c; cement, including hauling to field, 13.0c; gravel, 5.0c; mixing, 2.5c; placing, 4.2c; finishing, 0.5c; sprinkling and protecting, 0.2c; water, 0.4c; repairs and supplies, 0.3c; equipment charge, 0.5c; giving a total for labor and material of 34.2c. To this was added 0.2c for superintendence; 0.7c for engineering, and 4.4c. for general expense. Prior to 1916 the lining was placed at a cost of 27.8c for labor and material and 6.5c for overhead, labor then receiving $2.50 per day and cement costing $2 per barrel.

The advantages of lining are: The reduced cost of maintaining the lined sections, reduced seepage losses, and greater carrying capacity. Comparative costs of maintaining earth and concrete lined sections on this canal are available covering 66 miles of earth and 31 miles of concrete-lined canal, and these show a cost of $55.70 per mile for earth, and $19.50 for concrete-lined sections during the season. The work of cleaning earth sections is performed with teams and scrapers and consists in the removal of silt deposits and all plant growth. In the lined sections small silt deposits are removed by hand and minor repairs are made to the lining. (1½-inch lining placed in 1911 and in continuous use since then is still in excellent condition with no indications of disintegration or failure.)

By means of current meter measurements and discharge over weirs, seepage and evaporation losses of canals located in the different soil locations of the project and in the concrete-lined sections have been determined during each irrigation season since 1912. The mean results give the following losses in feet per day per unit of wetted perimeter: Concrete lined, 0.29; clay 0.63; gravelly clay, 1.38; loam, 1.40; gravelly loam, 1.47; sand and gravel, 2.85. The evaporation would presumably be the same in all cases, so that the differences indicate those due to the soil or lining and that the loss is less than half as much with concrete lining as with clay.

Another advantage is that the capacity of the canal is increased, not only because of absence of vegetable growths, but also because greater velocity can be maintained with safety. Also there is comparative freedom from washouts and breaks.

Hydrant Rental in Omaha

In 1911 the city of Omaha, Nebraska voted 8½ millions of bonds to purchase the water plant and to make extensions and improvements. The bonds contained a proviso that the city, in order to insure the payment of interest, would levy an annual water tax, and under this proviso the city is now compelled to pay $191,000 a year as fire hydrant rental under the statute adopted. The waterworks plant has made all necessary payments to date, has retired $600,000 of the 7½ millions actually sold, and has in the sinking fund $1,700,000 in excess of the requirements for interest and maturing bonds.

The city council, desiring to reduce taxes, proposes to discontinue the payment of hydrant rental, declaring the law above referred to unconstitutional, and refused to levy taxes for this purpose this year. The Water Board then obtained an order of

mandamus compelling the making of the levy, from which the city has appealed declaring that it was no business of the Water Board as to whether what the Council did was legal or illegal, the Council being responsible only to the voters of the city, and claiming that the provision contained in the bond was illegal, and if legal was not irrevocable.

Water Main Joints in St. Louis

In his latest annual report, the water commissioner of St. Louis, Edward E. Wall, describes an investigation made of jointing materials used for cast iron pipe. The investigation was made in connection with a study of electrolysis and methods of preventing it, the idea being to make the mains as nearly non-conducting as possible by using non-conducting materials for all the pipe joints.

Pig lead, the standard joint material, is a better conductor than the cast iron itself. This fact, together with the rising price of lead, formed the incentive for a series of electrical resistance tests which were recently made on three lines of 3-inch cast-iron pipe, one laid with lead joints, one with cement and the third with leadite, an old established patented compound which requires no caulking. After finishing these tests, both with the pipes full of water and empty, the lines were put through a very severe deflection test by raising and lowering one end with a derrick.

A summary of the conclusions from this test is given by Mr. Wall as follows:

1. Cement and leadite are far superior to lead as insulators and the insulating value of these materials is not vitiated by the water in the pipe. Their use would have prevented most of the electrolytic trouble to which our cast-iron system is subject at present. This statement is made in full cognizance of the fact that the insertion of an occasional insulating joint may lead to joint electrolysis caused by the current leaping around this particular joint and continuing along the pipe line. The point is that if every joint were insulated the current would not have the incentive to travel the main in the first place.
2. Cement and leadite will stand far more deflection than lead without serious leakage.
3. Lead and leadite joints can be made in any season and under adverse conditions, while cement is at a disadvantage in Winter and in wet trenches.
4. Lead and leadite joints permit the water to be turned on and the line put in service immediately, while cement requires a period of preliminary setting.
5. Cement joints are very hard to gouge out.
6. The sulphur fumes given off by the melted leadite might become very oppressive in a confined space.

Cement Lined Cast Iron Pipe

Reference was made in PUBLIC WORKS a few months ago to the recent experiments of the Water Department of Charleston, S. C. in lining cast-iron pipe with cement. In his annual report for 1922, J. E. Gibson, manager and engineer of the Water Department, reports on the work done in this line up to the end of the year.

For several years the Department had been dissatisfied with the protective coating used on cast-iron water mains as used with the Charleston water. Mr. Gibson had had considerable experience with the use of cement-lined wrought-iron pipe as manufactured by the American Pipe and Construction Company under the Phipps patent, which has now expired, and made an arrangement with the American Cast Iron Pipe Company of Birmingham to undertake experiments in the manufacture of cement lined cast-iron pipe. A plant for this treatment and a process were finally perfected so that satisfactory pipe was turned out by May 15th, 1922 and the actual manufacture of pipe commenced about June 5th. In arranging for these experiments, the city had agreed to take about 15,000 feet of 6-inch, 12-inch and 16-inch pipe if a satisfactory product could be obtained. At the end of the year it was reported that the city had in service 1183 feet of 4-inch cement-lined cast-iron mains, 17,681 feet of 6-inch, 822 feet of 8-inch, 1,578 feet of 12-inch and 12,431 feet of 16-inch.

Experiments were made upon sections of 6-inch and 16-inch cement-lined pipe to determine the value of the co-efficient C in Hazen & Williams formula for flow of water in mains, and the values determined from these experiments indicated a much higher carrying capacity of cast-iron pipe when lined with cement than when given the ordinary coating. Moreover, the department feels that the high value would be maintained indefinitely, as examinations of other cement-lined pipe in use from 25 to 30 years have shown no signs of tuberculation or incrustation. An additional advantage is that the cement lining effectively prevents rusting of the interior surface and will presumably reduce red water troubles for consumers.

"The department has, therefore, adopted cement-lined cast iron pipe for all future extensions within the city limits and on all improved streets."

Locating Water Pipe Leaks*

What is going on underground is often a matter of such importance and yet so uncertain that it may be of interest to water works men to hear of some experiences with the geophone, a development of underground war operation to detect enemy mining and sapping.

The instrument exteriorly consists of two discs, each about 1 inch thick and 4 inches across, from each of which leads a tube ending in an earpiece. The whole affair is not unlike a stethoscope.

In use the discs are placed on the road surface and an earpiece in each ear. If a leak is suspected in a given locality, by placing the two discs as far apart as the lengths of tubes permit, it will be found that the noise in one ear will be louder than in the other. The less loud disc will then be shifted backward and forward until the sounds from both are equal.

*Paper by Francis W. Collins, consulting engineer for the Roanoke Water Works Company, in the Journal of the American Water Works Association.

The assumption follows that the sound is in the plane perpendicular to the straight line joining the two discs. Mark this observation spot, then proceed along the direction of this plane forward or backward whichever way, on trial, intensifies the noise.

The time necessary to locate an ordinary leak when within 50 or 75 feet of it is usually only a few minutes and not over 15 or 20.

There are some points of interest worth following by one using the geophone for the first time:

(a) The operation must be carried on at a time of no traffic or other street noises. It was found that a street sweeping machine of the revolving broom type two or three blocks away on a brick pavement made so much noise that it was distinctly heard in the geophone. The early morning is practically the only time, except in outlying districts, the instrument can be used.

(b) The operator must learn what to listen for. He may pick up all kinds of noises.

(3) The noise from a leak, apparent through the geophone, will depend on against what the leaky water impinges. If the stream is against a ledge of rock, a roar like a cataract may result; the volume of sound does not necessarily indicate the size of the leak. No observations have been made as to the effect produced by different characters of apertures through which the leak might be taking place.

Although not tested under all conditions so as to determine what the geophone will not do, enough has been learned through its use to prove its value for what it will do. We are now interested in learning the smallest leaks it will disclose and under what conditions.

Three examples will show what it will do:

(1) A ½-inch service 2½ feet deep, leaking a stream smaller than a lead pencil, under 8 inches of brick and concrete base pavement was heard fifty feet away (how much farther it might have been heard was not determined) and was located exactly, saving nearly the cost of the geophone through not having to cut up the pavement. There was no surface indication of where the trouble was. It was only known that there was a leak in a certain block.

(2) A leaking half-inch service in a 6-inch reinforced concrete pavement, 3½ feet deep, was located. Before starting, the suppositions were that a joint in a 16-inch main might be blown, or a valve was leaking, or a service had gone out. The geophone got on the job and left no doubt that a service was involved and located the exact spot at which to break through the pavement with a consequent saving in cost. It was only necessary to open the concrete pavement enough to permit a man to work.

(3) The local gas company was laying a main parallel to ours and discovered a considerable volume of water which was reported leaking from the water main. Inspection at fire hydrants, meter and valve boxes failed to disclose any leaks. The geophone was used showing no leaks whatever. Later it was proved that the water was ground water from a clayey soil.

The use of this instrument has been in the hands of Mr. Charles E. Moore, Assistant General Manager, and Mr. D. R. Taylor, Assistant Superintendent, of our Company, and I am indebted to them for the above data.

Dayton Waterworks

During the year 1923 the Division of Water of Dayton pumped 6,145 million gallons of water. Its receipts for the year amounted to $479,108. The operation charges totalled $171,857, while bond payments were made amounting to $233,487. In addition, the division gave, as is the case in most cities, a large amount of free service. Without crediting any of this free service, and including the bond payments with the operating charges, there was a net profit to the division of $73,764.

During the year the supreme court of the state decided that municipalities owning water plants cannot use the surplus revenue from such plants for any purpose other than the extension and operation of that utility. The city of Dayton had been using approximately $130,000 a year from the receipts of the Division of Water for its general operating expenses. Beginning this year, however, it has been necessary for the city to maintain a waterworks fund separate from the general fund. This, which has been the established practice in so many of the eastern cities, was apparently considered a hardship by Dayton and an effort is being made to charge against this fund 10 per cent. of the gross revenue to be paid to the city in return for the supervision of the waterworks service. $45,000 to $50,000 a year would seem like an excessive charge for supervision, over and above the amount presumably paid as salaries to the superintendent and others immediately in charge of the division.

Water Supplies from Valleys

Development of such a supply includes selecting location for wells, examining records of previous borings, study of geology, and comparison of available supplies.

In a paper presented before the Illinois section of the American Waterworks Association, W. D. P. Warren, consulting engineer of Decatur, Illinois, discussed the subject of obtaining ground water supplies from pre-glacial valleys, in which type of valleys, he stated, such supplies are generally found. He described in some detail investigations made for two cities in central Illinois as being somewhat typical. He then gave as a general statement, the following conclusions:

"The investigation for a new or of an additional water supply should be conducted along broad lines, keeping constantly in mind that such investigations may be properly extended a distance of five, ten, twenty or more miles beyond the city limits. A few comparisons in cost may show that a well supply may be developed at distances not heretofore seriously considered. The present lower cost of cast iron pipe and the high cost of reservoir lands, are factors which will influence a final decision.

"Keeping clearly in mind the fundamental principles which govern the development of a shallow ground water supply, and realizing the relation thereto of deposits in the pre-glacial valley, it will be of interest to consider proper methods of de-

velopment. These may be briefly summarized as follows:

"1. An examination of the extent of all possible water shed areas within reasonable distance. As a rough rule, we might say that a city of 2,000 population may economically develop a well supply at a distance of not over five miles, while a city of 50,000 might economically develop a well supply at a distance of not over fifteen or twenty miles, depending on availability of natural reservoir sites, relative elevations, cost of land, etc. The advantages of a well supply, with low first cost and low operating cost, will justify extending our investigations over a wider field than generally considered necessary.

"2. An examination of well records, test holes, borings and other data in the territory under consideration. Such records may often be secured from coal, oil or gas companies, local well drillers, and of most importance in this State, through the State Geological Survey at Urbana. Some such records are confidential, however, the portion relating to depth of glacial drift is not, and may generally be secured to be used in the investigation of a municipal supply.

"3. A thorough study of all available records with a view to determining the dip of the rock or shale at base of glacial drift and the location of pre-glacial valley. This study should be made before the location of any additional drill holes is considered. Often the elevations as disclosed by the records of two or three old holes will indicate the direction of the pre-glacial valley, and a little further investigation should definitely establish its boundaries.

"4. The application of knowledge obtained through above studies and the location of test holes in accordance therewith. Such test holes should furnish sufficient additional data to determine the possibilities of any site under consideration.

"5. With complete and accurate data upon these principles, a conclusion may then be reached as to the value of such a supply, compared with a surface supply, and recommendations may be made regarding future developments with a full knowledge that all facts relating thereto have been properly considered and analyzed."

Garbage Disposal in Dayton

The city of Dayton, Ohio, during 1922 collected garbage sufficient to load 399 railway cars at a cost for collecting, hauling and loading of $52,459. Of this amount of garbage, 375 carloads were sent to the garbage reduction plant and 24 to the city workhouse for feeding hogs. This latter amount was selected garbage of the best grade which had been collected from the hotel and restaurant district by daily collections. The cost of collection was calculated to be $2.37 a ton.

From the 375 carloads, or 18,750 tons, of green garbage delivered to the reduction plant, 934,805 pounds of grease was produced, or 49.85 pounds per ton of green garbage. The amount would have been greater had not the percolator broken down on Nov. 16th and the extraction of grease been discontinued from that date until the end of the year, during which time 5,100 tons of garbage was delivered to the plant. In removing the grease there were used 9,205 gallons of high-test gasoline. This average of about one-half gallon of gasoline per ton of garbage is considered very low.

The total quantity of tankage produced was 1,762,270 pounds, or 94 pounds per ton of garbage. It required 2,966 tons of coal to operate the plant, or an average of one ton to 6.35 tons of green garbage.

The total cost of operating the plant was $57,594, an average of $3.15 per ton of garbage. As the income from the sale of grease and tankage was $56,500, it is seen that this fell about $1,000 short of equalling the operating cost of the plant, without considering any overhead costs. This, however, is a much better showing than was made last year by several other reduction plants.

Disposal of Street Sweepings

Methods reported by nearly two hundred cities and tabulated elsewhere in this issue. Most dump their sweepings. Those of ten cities used as fertilizer.

The character of street sweepings has changed very materially during the past twenty-five years. Prior to that time a large percentage of the streets in American cities were macadam, gravel or earth, with only a few blocks in the business center paved with asphalt or brick. Consequently street sweepings contained large amounts of earth and gritty material from macadam stone. With the great increase in amount of asphalt, bituminous concrete, cement concrete and brick pavements, the amount of this mineral matter has diminished materially.

Even more essential has been the change due to substitution of automobile for horse-drawn traffic. With the great diminution in the number of horses on the streets, the amount of horse droppings in the sweepings has become very small in most cities, while the automobiles have contributed more or less oil to be absorbed by the dust on the pavement. This results in a considerable decrease in the fertilizing value of the sweepings combined with a direct disadvantage caused by the presence of oil in the material, which tends to clog the soil and possibly even inhibit vegetable growth.

In spite of the changes indicated above, several cities and villages reported, on the questionnaire sent out by us last month, that the sweepings from their streets are used for fertilizer. Of 189 municipalities reporting, five used the sweepings as fertilizer on parks, cemeteries or other property, while five report that it is used by private parties, three of them being able to sell the sweepings for that purpose. One of these, Napa, California, sells sweepings for the cost of hauling, which is estimated at 50c a yard. H. A. Harrold, city engineer and superintendent of streets,

writes us: "Five or six years ago when autos did not leave so much oil on the streets we sold them as fast as collected. Now, however, people who have truck gardens in their backyards do not buy them because they believe that the oil destroys the plants. Nevertheless we sell them to Italian ranchers who keep them until thoroughly rotted before using. . . . I expect some time in the future we will have to give them away to get rid of them." Purchasers furnishing their own wagons obtain the sweepings for 25c a load.

S. Cameron Corson, borough engineer of Norristown, Penna., reports that on the permanently paved streets of that borough the only dirt found consists of manure and leaves, and this is gathered up by property owners and stored as a fertilizer. Incidentally he states that, except in the business part of the town, the streets are not cleaned regularly by the borough but that the citizens have sufficient pride to each clean the street in front of his own property. The street sweepings, where they are not saved for fertilizer, are placed in ash receivers, the contents of which are removed by the citizens at their own expense.

Only about 5% of the cities, however, report the use of street sweepings as fertilizer. Seven municipalities report the burning of street sweepings, four of them in incinerators. One buries the street sweepings. The great majority, however, dump the sweepings at various points, some utilizing them as fill. Seventy-seven report merely "dumping," "dumping on low land," etc., 6 of them specifying that they are dumped along with garbage. Thirty-seven others specify that they are placed on public dumps and 4 on private dumps. Five others specify they are dumped outside the city, 1 in a gravel pit and 1 in a quarry. Four report dumping in a river or other body of water. Twenty-nine report that the street dirt is used for filling in land or low lots and 3 that it is used in grading up streets; 1 uses it for making land for a public landing, 1 for building a dike along the river and 1 uses it for covering ash dumps. Altogether 171 report disposing of the sweepings by dumping or filling in low land.

Even before the change in character noted above, there was not much danger of nuisance from the dumping of street sweepings if reasonable care was taken in selecting the location of the dump and keeping it in order. With the change in character noted, the objectionable features have considerably decreased in importance. While the fertilizing value of sweepings has decreased, there are possibilities in the suggestion from California that by storing the sweepings for some time the objectionable characteristics of the oil may largely disappear. The presence of grit, leaves, etc., is of value in lightening clay and other heavy soils.

DISPOSAL OF STREET SWEEPINGS AND GARBAGE

City	Disposal of Street Sweepings	Change in Disposal of Garbage This Year	New Method Contemplated	Reason for Making Change
Alabama:				
Florence	Incinerator	None	None	.....
Gadsden	Burned	None	.....	.....
Talladega	Dumps	None	.....	.....
Arizona:				
Tucson	Hauled to dumps	Dumping	Building incinerator	Flies and general nuisance of dumps
Arkansas:				
Fayetteville	Hauled to city dumps	.....	Building incinerator	Difficulty in finding satisfactory dumping ground
California:				
Monterey	Dumped outside city	None	Garbage disposal plant	To alter expenses
Napa	Dump and sell	.....	.....	.....
Redlands	Fertilizer on city prop.	.....	.....	.....
Santa Ana	Filling low ground	None	None	.....
South Pasadena	Fill	.....	.....	.....
Colorado:				
Denver	Fill low places	None	None	.....
Connecticut:				
Hartford	Public dump	None	None	.....
New Britain	Dumps	Private contractors	Change discussed	Irregular collections
New Haven	Public dumps	None	None	.....
New London	Dumps	None	None	.....
Willimantic	City dumps	None	None	.....
Florida:				
Key West	Filling low ground, city property, combustible matter burned	.....	.....	.....
St. Petersburg	Dump	None	To build 80-ton incinerator	Present incinerators of insufficient capacity
Georgia:				
La Grange	Incinerator	None	None	.....
Idaho:				
Lewiston	City dump	None	None	.....
Twin Falls	Dump and low streets	City hauling to private haulers	Contract with private company	Obviate expense & trouble of maintaining teams
Illinois:				
Canton	Fill low places	Regular collections	.....	.....
Centralia	Low lots and ravines	None	None	.....
Freeport	Dumped	.....	.....	.....
Kankakee	Dump in old quarry	Feeding to hogs instead of dumping in quarry	None	Bad odors
Oak Park	Dump	None	None	.....
Quincy	Dump in hollows	None	None	.....
Sterling	Dump	None	None	.....
Urbana	Haul to dump	None	None	.....
Winnetka	Village dump	None	Buy site for disposal plant	.....
Indiana:				
Bedford	Fill low lots	None	.....	.....
Brazil	Fill low land	.....	.....	.....
Elkhart	City dump	None	None	.....
Gary	Filling & burn for sts.	Feed to hogs	None	.....
Hartford City	People use for fertilizer	None	None	.....
Indianapolis	Haul to dump	.....	.....	.....

DISPOSAL OF STREET SWEEPINGS AND GARBAGE

City	Disposal of Street Sweepings	Change in Disposal of Garbage This Year	New Method Contemplated	Reason for Making Change
Indiana (Contd)				
Lafayette	Haul to dump	None	None	.....
La Porte	Haul to city dump	None	None	.....
Lebanon	Haul to dump	None	None	.....
Shelbyville	Haul to dump	None	Change of some kind probable	Collection by contract unsatisfactory
South Bend	Filling low ground	None	None	.....
Terre Haute	Haul to city dump	.....	.....	.....
Wabash	Haul to dump	None	None	.....
Iowa:				
Cedar Rapids	Haul to dump	None	None	.....
Charles City	Taken to dump	None	None	.....
Des Moines	Sent to dump	.....	.....	.....
Keokuk	Hauled to dump by contractor	None	None	.....
Ottumwa	Filling	None	.....	.....
Kansas:				
Iola	Taken to dump	None	None	.....
Pratt	Fill low places	None	None	.....
Kentucky:				
Ft. Thomas	Use for fill	Collect by motor trucks	.....	Large mileage and scattered population
Louisville	Dump on river front	None	Building incinerators	.....
Mayfield	Fill outside city	One horse wagon added	Discuss'g disposal plant	.....
Maine:				
Bangor	Local dumps	Truck for collecting	.....	.....
Rockland	Making land for public landing	None	None	.....
Massachusetts:				
Adams	Dumped	.....	.....	.....
Brockton	Dumped	None	None	.....
Cambridge	Open dump	None	None	.....
Concord	Haul to dump	Do not collect	.....	.....
Gardner	City dump	None	None	.....
Haverhill	Haul to dumps	.....	.....	.....
Hudson	Farmers remove	None	.....	.....
Natick	Gravel pit, burned when possible	None	None	.....
Northbridge	Dump	None	None	.....
Orange	Dump	.....	.....	.....
Reading	Dump	.....	.....	.....
Michigan:				
Alma	Fill at city dump	Contracted	None	.....
Ann Arbor	Fill low lots	None	Question	Contractor does not remove garbage satisfactorily (he feeds to pigs). Incinerator not used because of high price of coal
Flint	City dumps	None	None	.....
Grand Rapids	Dumps on low ground	None	None	.....
Highland Park	Hauled to dump	From incinerator to hog feeding	None	Cheaper and shorter haul
Holland	Part used in parks, poorest dumped	.....	.....	.....
Manistique	Filling new park	None	None	.....
Muskegon	Dump	None	Incinerator	Nuisance
Pontiac	Filling	None (hog farm)	.....	.....
Port Huron	Dumped	None	Not immediately	.....
Minnesota:				
Chisholm	In incinerator	None	None	.....
Cloquet	Hauled to dump	None	.....	.....
Hibbing	Garbage dump	.....	.....	.....
Rochester	Fill low ground	None (fed to hogs)	None	.....
St. Paul	City dumps	Now installing 2 tractors and 12 trailers for collection in part of city	.....	Too long haul to garbage dumps
Willmar	Dumps	None	None	.....
Missouri:				
Jefferson City	Dumped in river	.....	.....	.....
Kansas City	Fill low places	None	Build disposal plant	Economy and sanitation
Marshall	City dumps	None	Not decided	.....
St. Charles	Public dump	None	None	.....
St. Joseph	City dump	Franchise granted one company	None	.....
Sedalia	Private dump outside city	None	None	.....
Montana:				
Bozeman	City dump	None	None	.....
Lewistown	Fill low ground in city	None	None	.....
Livingston	City dump	None	None	.....
Nebraska:				
Lincoln	Filling low places, and dumps	.....	.....	.....
Norfolk	Filling low areas	None	.....	.....
Scotts Bluff	City dump	.....	.....	.....
New Hampshire:				
Nashua	Cover for ash dumps	.....	None	.....
New Jersey:				
Asbury Park	Vacant low lands	None	None definitely	.....
Irvington	Fill in low lands	None	Constn. of incinerator	Growth of town eliminates dumping places
Salem	Fill on outskirts of city	Do not collect	.....	.....
Westfield	Fill unoccupied low spots	None	None	.....
New Mexico:				
Albuquerque	Build dike along river	None	None	.....
New York:				
Endicott	Ash and garbage dump	None	None	.....
Gloversville	Dump	None	None	.....
Johnson City	Dump	.....	.....	.....
Kingston	Dumps	None	None	.....
Norwich	Dump in abandoned river channel	None	None	.....
Tonawanda	Public dump	None	None	.....

DISPOSAL OF STREET SWEEPINGS AND GARBAGE

City	Disposal of Street Sweepings	Change in Disposal of Garbage This Year	New Method Contemplated	Reason for Making Change
North Carolina:				
Gastonia	Fertilizer	More equipment	Increase efficiency	.....
Thomasville	Haul to dump	None	.....	.....
North Dakota:				
Fargo	Dump on low ground	None	Incineration	Dump becomes increasingly obnoxious as city grows
Ohio:				
Akron	Haul to dump	Fed to hogs	None	.....
Bucyrus	City dump	Patrons pay for service	None	.....
Chillicothe	Low places on outskirts	None	Install incinerator	Eliminate long and expensive hauls, abolish stench and reduce cost
Cincinnati	City dumps	Separate contract	None	Bids for removal to be advertised for during coming year
Circleville	Dump on private prop.	None	None	.....
Dayton	City dumps	None	None for a year	Plant too small
Delaware	Private lots or city dump	None	None	.....
East Youngstown	Haul to dump	None	None	.....
Findlay	Dump outside city limits	None	None	.....
Fremont	Haul to dump	None	None	.....
Lima	Dump	.....	Hope to build inciner.	.....
Mansfield	Haul to dump	Built new incinerator	.....	Additional capacity
Middletown	Vacant lots and city dump	None	None	.....
Urbana	City dump	None	None	.....
Van Wert	City dump	None	None	.....
Zanesville	Neighboring lots or public dump	Delivers to farmers at edge of city	None	.....
Oklahoma:				
Blackwell	Dumps	None	None	.....
Chickasha	Municipal dump (burning)	Contract	Incinerator	Contractors not responsible; many complaints
Enid	Low streets and alleys	Contract	None	.....
Oregon:				
Astoria	Hauled 1 mile to garbage dump	None	None at present	.....
The Dalles	Dumping ground	.....	.....	.....
Pennsylvania:				
Ashland	Borough dump	.....	.....	.....
Butler	City dump	None	None	.....
Carbondale	Dumps	None	Problematical	.....
Clairton	On low ground	None	None	.....
Clearfield	Sold as fertilizer	Have no system	None	.....
Dormont	Park fill and fertilizer	Contractor collects and feeds to hogs	None	.....
Forest City	Dump	None	None	.....
Freeland	Borough dump	None	.....	.....
Hanover	Fill low places	In old quarry 1½ mi. from town	None	.....
Lancaster	Public dump	None (Incinerator not used—Coal too dear)	.....	.....
Meadville	Fill	None	None	.....
Munhall	Refuse dump	None	.....	.....
Norristown	Public dump	Contract for $9,000; fed to hogs 5 mi. from city	None	.....
Philadelphia	Dumps	Now building incinerator for part of city	.....	To dispose of garbage collected at excessive distance from reduction plant
Rankin	Haul to dump	None	None	.....
Steelton	Garbage dump	None	None at present	.....
Swoyerville	Fill low land	None	None	.....
West Pittston	Dumped	None	None	.....
Woodlawn	Refuse dump	None	None	.....
Rhode Island:				
Pawtucket	Public dump	None	None	.....
Woonsocket	Dump	None	None at present	.....
South Carolina:				
Chester	Dumped on farm	None	None	.....
Orangeburg	Fill low bottom lands	None	.....	.....
South Dakota:				
Lead	Haul to dump	None	None	.....
Rapid City	Fill low places	None	.....	.....
Tennessee:				
Jackson	Haul to dump and incinerator	None	None	.....
Kingsport	City dump	.....	.....	.....
Murfreesboro	Dump	None	None	.....
Texas				
Amarillo	Dump grounds and isolated holes	20-ton incinerator inst.	None	.....
Burkburnett	Haul to dump	None	City control garbage wagons	Give better service to residential sections
Childress	Canyon dump	.....	Incinerator	.....
Del Rio	Dump	None	.....	.....
Eastland	Buried	None	None	.....
San Angelo	Dump	None	None	.....
Vermont				
Brattleboro	Dump in river	None	None	.....
Rutland	City dump	None	None	.....
Virginia				
Danville	Used with manure in parks and cemeteries	None	Hope to	.....
Fredericksburg	City dump	None	None	.....
Harrisonburg	City dump	.....	.....	.....
Newport News	Dump on low ground	None	None	.....
Richmond	Dumps	None	Must install plant within 3 years	.....
Staunton	Sold for fertilizer	None	None	.....
Washington				
Aberdeen	Haul to low lands	None	None	.....
Walla Walla	City dump	.....	.....	.....
West Virginia				
Clarksburg	Dump on waste land	None	None	.....
Fairmont	Haul to nearest dump	None	Possibly incinerator in 1924	Burning garbage on open dump very objectionable
Wisconsin				
Baraboo	Dump	.....	.....	.....
Beaver Dam	Dump	None	None	.....
Kenosha	Dump into enclosed area of Lake Mich.	None	.....	.....

Economics of Highway Grades

Under the above title a bulletin has been published by the Engineering Experiment Station at Ames, Iowa, having been prepared by T. R. Agg, highway engineer of the Experiment Station, to present, in the nature of a progress report, tentative conclusions from experiments that are still being continued.

In 1919 this experiment station began an investigation of the economics of grades for highways based on motor-drawn rather than horse-drawn traffic and several years will be required to evaluate all the factors that enter into the problem. The investigation was carried out by Mr. Agg, assisted part of the time by Prof. W. L. Foster of the Civil Engineering Department; while the Iowa Highway Commission cooperated by loaning trucks and small equipment. The vehicles used in the test were a 1.85-ton Buick with pneumatic tires, a 4.14-ton light aviation army truck with Goodyear cord tires, and a 7-ton heavy aviation army truck with solid front and dual solid rear tires.

An analysis of the problem from the purely theoretical standpoint, considering only fuel consumption and speed of motor vehicles, indicated that the three factors controlling the economical maximum grades for motor vehicles are: length of grade, resistance to translation on the particular road surface, and maximum tractive effort of the vehicle. To study the relation between these, records were desired of fuel consumption and other pertinent data for vehicles operating under normal conditions on hilly roads. Special appliances were devised for measuring minute amounts of gasoline consumption, that adopted having as its essential feature a piezometer ring, the velocity head at which is measured by a calibrated diaphragm.

A number of runs were made with the different vehicles over different grades and at different speeds and the results obtained as to fuel consumption were plotted. A study of the diagrams indicates that, if fuel consumption only be considered, the most economical highway grade for descending traffic is that rate of grade that will permit the vehicle to descend without obtaining an unsafe speed and without the use of a brake; the economical maximum rate of grade for ascending traffic is that which will permit the vehicle to ascend without changing gears and at a speed that permits the motor to operate most efficiently; and this maximum will depend upon the resistance to translation of the vehicle, the length of the grade, the allowable limits of speed and the tractive power of the vehicle.

The bulletin considers these points from a theoretical point of view and develops formulas for comparing per cent of grade, length of grade, resistance to translation and speed of vehicle; also formulas for allowable expenditure for reducing grades. Finally, the conclusions to date are summed up as follows:

"In the foregoing discussion there is presented a tentative economic theory of highway grades. The value of the deductions depends upon the sufficiency of the experimental data and the accuracy of the assumptions relative to the characteristics of the composite vehicles. There has been analyzed a great mass of data bearing on the subject and extensive field investigations have been in progress for 3 years, but the subject involves so many variables that the results presented herein can hardly be considered more than the first step in the establishment of an adequate theory of highway grades. Amplifications and refinements to the theory will be made by those interested as rapidly as pertinent experimental data are available.

"If the principles presented herein are considered in connection with trunk-line highways, where the annual traffic may reach several million tons, it will be apparent that the actual value of the fuel saved by grade reduction may reach very significant sums.

"That value of lost time due to excessive grades is an even larger sum, where the volume of commercial vehicle traffic is large, and undoubtedly a similar loss accrues to a considerable percentage of the automobile traffic. It is highly important to establish a basis for evaluating lost time, but it is one of those elusive quantities which are difficult to analyze.

"It seems to have been established that momentum grades on rural highways are economical both from the standpoint of fuel and time and that, under certain circumstances, less fuel will be required on a road with an undulating grade line than on one with very flat grades. It is also shown that no economy results from the reduction of long grades of less than 3 per cent and that short grades may reach 8 per cent without adversely affecting either fuel consumption or average speed.

"Fuel cost is an item amounting to only 15 or 20 per cent of the cost of operation of a motor vehicle, but a saving of one-tenth of the fuel annually consumed in a state will amount to a large sum.

"Almost invariably those things that lower fuel consumption also lower maintenance costs for the vehicle and thus indirectly effect a saving in repair bills and tire wear, which is considerably larger than fuel saving.

"One interesting fact brought out in the fuel consumption runs was the marked saving in fuel that results from coasting down hill with the motor declutched. This is a perfectly feasible way to drive an automobile but may be dangerous with a commercial vehicle. It should not be practiced with any kind of vehicle on long grades or where safety considerations require the vehicle to be kept under control.

"Safety, aesthetics and drainage considerations in connection with grade reduction are outside the scope of this investigation, although they are factors that must always be considered in connection with highway improvement."

Justification of Highway Expenditures

The Department of Highways and Public Works of Tennessee, of which J. G. Creveling, Jr., is Commissioner; C. N. Bass, First Assistant State Highway Engineer and R. H. Baker Second Assistant State Highway Engineer, is urging a construction program of eighty-six million dollars, and in justification of this sum presents the following calcula-

tion of the value of the service that such expenditure would make available.

"The highways of Tennessee are serving a real transportation need. More improved highways will increase the annual service and decrease the present cost of transportation. To August 1, 1923, there were registered 151,718 autos and trucks, 134,316 autos, and 17,402 trucks. Traffic studies show that these vehicles travel annually at least 2,000 miles each on the public roads. Each auto carries on the average 2.2 passengers, and each truck carries an average of two tons. The transportation service is therefore:

134,316x2,000x2.2—590,990,000 passenger miles
17,402x2,000x1.0— 54,800,000 ton miles
(*Trucks travel one way empty*)

"Assuming a fair charge for this service to be 1 cent per passenger mile and 2 cents per ton mile, the annual value of the service would be approximately $7,000,000. During the next five years the above registration will increase 50 per cent, making the service to correspondingly increase, or making the annual service $10,500,000.

"Subtracting the annual needs for maintenance, depreciation, and management, there would remain $6,150,000 annually, which capitalized at 5 per cent, would justify a construction program of $123,000,000.

"It is thus seen that a construction program of $86,000,000 is more than justified, leaving nearly forty million dollars to improve additional highways of the state."

The department emphasizes the importance of maintenance, and of considering the cost of this in selecting type of road. It makes the folowing comparison of annual cost of fine types or roads. The authority for or source of the figures is not named.

ITEM	Ordinary Gravel	New Carpet Treated Macadam	Penetration Macadam	Cement Concrete	Earth
First Cost Per Mile.	$5,000	$18,000	$22,000	$33,000	$1,000
Life of Surface	5	10	10	20	indef.
Annual Int. at 5%...	250	900	1,100	1,650	50
Maintenance	300	750	550	230	250
Cost of Resurfacing.	2,500	9,000	11,000	23,000	None
Annual Sinking Fund	466	767	852	814	None
Annual Cost.....	$1,016	$ 2,417	$2 502	$ 2,694	$ 300

It is seen that on this basis cement concrete is the most expensive and earth the least. No reference is made to the kind or amount of traffic that can be carried on an earth road indefinitely without ever resurfacing and with an annual maintenance cost of $250 a mile; nor to that which can be carried on a carpet-treated macadam for ten years, or half as long as a concrete road will last.

State Construction of Roads

The State Highway Department of Michigan has decided to build its roads by force account rather than by contract and one result of this is brought to our attention by a letter from one of our subscribers who is a contractor in that state. He states that he has confined his work largely to concrete road building and "with the state doing all the roadwork we do not see that there is anything left for us to do except to endeavor to dispose of our equipment and liquidate."

Selection of Pumping Equipment*

Securing maximum station economy in choice of class of pumping equipment for supplementing existing plant.

The author discussed this subject in connection with the problem of selecting a pumping unit to meet increased demand upon an existing plant. In comparing the various types the author based his figures on units of about 3,000,000 gallons per day capacity, as the majority of pumping plants in New England are of that size or smaller. He also assumed that the existing plant is a steam operated one having a good boiler equipment.

CRANK AND FLYWHEEL

The crank and flywheel pumping engine is without question the most economical in the use of steam, being able to deliver about 124,000,000 foot-pounds per thousand pounds of steam under the ordinary steam conditions found in existing pumping stations. This class of engine also has an excellent record for dependability and low cost of upkeep. The cost is higher than that of other types, but even with the high cost this type is a favorite where maximum steam economy is the main consideration.

Where the capacity of a steam plant has been reached and the type is obsolete, such as direct-acting compound pumps, a crank and flywheel engine should receive serious consideration if there is available space for it; but if installing such an engine would entail an expensive addition to the building the resulting fixed charges might be greater than would be warranted even by the high duty of the plant.

TURBINE DRIVE

The turbine driven centrifugal pump has the advantage of low first cost and very small space requirements as compared with the crank and flywheel engine. It will give, however, a duty of only 100,000,000 foot-pounds. An additional advantage is the very small foundation needed and the ease of arranging suction and discharge pipes.

*Abstract of paper by Frank A. Mazzur before the New England Waterworks Association.

If the problem is that of a plant which already contains an economical pumping engine for regular service but for which a new standby unit is desired, a steam turbine driven centrifugal pump offers the best solution, for it requires no more space than a direct-acting duplex pump of considerably less capacity, the price is as low as that of any dependable pumping equipment, and even if operated for long periods the operating cost would not be very much above that of the most economical type of steam pump.

ELECTRIC DRIVE

Where the boiler plant and all the steam machinery is in good condition, economy is seldom obtainable by changing to electric drive, especially in a plant of such size as to require only one man on duty for a steam plant, since one man would be required for an electric plant also, although there might be some saving in the possibility of using one who is not a licensed engineer.

An electrically driven pump may be either a plunger pump geared to an electric motor, or a centrifugal pump direct-connected to the driving motor. The plunger pump would be practically the same unit employed in connection with a crank and flywheel engine, while the direct-connected centrifugal pump would be the same as the one driven by the geared steam turbine. As in the case of comparing crank and flywheel and turbine driven pumps, the problem is simply one of fixed charges and operating costs. The guaranteed pump efficiency of the horizontal plunger type pump of this size is about 90 per cent. and that of the centrifugal pump about 80 per cent., and the operating costs of the two are surprisingly similar when both fixed charges and cost of current are considered.

In considering the installation of electrically driven apparatus it is very important to bear in mind the possibility of interruption of service, and where such interruption is possible, it is advisable to provide an additional drive of either oil or gasoline engine.

OIL ENGINE DRIVE

During the war great advances were made in the design of Diesel type oil engines and today they may be classed as prime movers that have demonstrated their value from the standpoint of both economy and dependability, and the author believes that this engine must be seriously considered by those aiming to operate their plants at the highest possible economy. A Diesel oil engine geared to a horizontal plunger pump of the size under consideration can give a duty far greater than the largest and most refined type of steam driven pumping unit that has ever been built. An oil engine driven unit of 3,000,000 gallons capacity can operate on a cost for oil equivalent to a duty of at least 225,000,000 foot-pounds per 1,000 pounds of steam. Moreover, with the oil engine, the efficiency of comparatively small units is almost as great as that of very large units, and this feature is making the Diesel oil engine a very attractive proposition for water-works pumping installations of small and medium size.

COMPARISON OF OPERATION COSTS

The author presented a table giving a comparison of operation costs of the various types of pumping equipment considered. In compiling this table he eliminated all items of operating cost that would be practically the same no matter what type of unit might be installed, and considered only the fixed charges of interest and depreciation, and the cost of fuel or current.

The interest and depreciation he has taken as 12% on the crank and flywheel engine and 15% on all the others. Coal is taken at $8.50 a ton and current at the charges made by the Boston Edison Company, which are 2c per k.w. on the basis of an 8-hour day, 1.7c on the basis of a 16-hour day and 1.64c on a basis of a 24-hour day. Current in other places will probably cost

COMPARISON OF OPERATION COSTS OF VARIOUS TYPES OF PUMPING EQUIPMENT, CAPACITY 3,000,000 GALLONS IN 24 HOURS, INSTALLED AS ADDITION TO EXISTING STEAM PLANT.

	Steam Driven		Electrically Driven		Oil Engine Driven
	Crank and Fly Wheel Plunger Pump	Turb. Driven Centrifugal Pump	Horizontal Plunger Pump	Centrifugal Pump	Horizontal Plunger Pump
Cost of unit installed with appurtenances and necessary change to building	$33,000.00	$15,000.00	$17,500.00	$10,000.00	$31,000.00
On Basis of Pumping Eight Hours Per Day.					
Interest and depreciation	$3,960.00	$2,250.00	$2,530.00	$1,500.00	$4,650.00
Cost of fuel or current	2,660.00	3,486.00	6,170.00	6,870.00	1,450.00
Cost of banking fires for 16 hours	820.00	820.00	.....	.....	.....
Cost of coal for heating	.....	.....	200.00	200.00	100.00
	$7,440.00	$6,550.00	$8,900.00	$8,570.00	$6,200.00
On Basis of Pumping Sixteen Hours Per Day.					
Interest and depreciation	$3,960.00	$2,250.00	$2,530.00	$1,500.00	$4,650.00
Cost of fuel or current	5,330 00	6,950.00	11,010.00	12,100.00	2,900.00
Cost of banking fires for 8 hours	410.00	410.00	.....	.....	.....
Cost of coal for heating	.....	.....	200.00	200.00	100.00
	$9,700.00	$9,610.00	$13,740.00	$13,800.00	$7,650.00
On Basis of Pumping Twenty-four Hours Per Day.					
Interest and depreciation	$3,960.00	$2,250.00	$2,530.00	$1,500.00	$4,650.00
Cost of fuel or current	7,990.00	10,400.00	15,700.00	17,250.00	4,350.00
Cost of banking fires	.....	.....	.....	.....	.....
Cost of coal for heating	.....	.....	200.00	200.00	.....
	$11,950.00	$12,650.00	$18,430.00	$18,950.00	$9,000.00

more than this rather than less, although somewhat lower rates may be obtained in localities adjacent to large water power. Steam and oil consumption was based on guarantees of the manufacturers.

If the plant has a large reservoir capacity, 8 hours pumping per day will usually suffice. With ample standpipe and small night consumption, two shifts may be possible; while where the pumping is against direct pressure, full 24-hour operation is necessary. The tabulation referred to is divided into three parts, one on the basis of pumping 8 hours a day, the second pumping 16 hours and the third 24 hours. The results naturally differ. It will be noticed that in this case the capacity of the pump is the same in each case and consequently the amount of water pumped per day will be twice as much in the second case as in the first and three times as much in the third case.

On the basis of an 8-hour day the oil engine driven pump is seen to have little advantage over the turbine driven centrifugal, because of the higher first cost; but where pumping is continued more than 8 hours, the economy of the oil engine driven is correspondingly increased because of the low fuel cost. In the 8-hour pumping the centrifugal pump is seen to have a slight advantage over the horizontal plunger, while the relative position of these two is reversed for the longer pumping days.

Where steam driven pumps only are considered, the crank and flywheel pump seems to be slightly less economical for the 8-hour and 16-hour day, but more so for the 24-hour period. The difference, however, is so slight that other considerations might readily control the choice. For instance, if money for purchasing the more expensive pump were readily obtainable, the other advantages of the crank and flywheel pump might decide a water board to purchase it, while the choice might be for the much cheaper centrifugal pump if money had to be borrowed.

In the case of the 8-hour day, the advantage in economy of the oil driven engine is so slight that it would not seem advisable to change to oil if the steam plant was in good condition and the operating force trained in handling it.

Considering the 16-hour day, the crank and flywheel engine would be chosen in preference to the turbine driven centrifugal because of its long life and reliability. Electrically driven pumps would apparently be out of the question in this case because of the high operating cost. The economy of the oil engine is considerably greater than of the steam driven pump in this case and installing it even in the steam operated plant would be seriously considered.

For the 36-hour pumping day, the electrically driven engine is apparently out of the question, while on the other hand the oil driven engine increases its lead over the steam driven.

The author states that in preparing this tabulation he used for the crank and flywheel pumping engine, the turbine driven pump and the electrically driven centrifugal pump, costs of installations actually put in. Of course costs of installation will vary in different plants and those given in the table are therefore to be taken as approximate. "Each and every installation is a problem in itself, and unless viewed from every angle and every factor carefully weighed, it is very easy to make a selection that will be disappointing in the results obtained."

COMPARISON BY ANOTHER AUTHORITY

In a paper before the Detroit convention of the American Waterworks Association last spring, Arthur L. Mullergren, of Kansas City, Missouri, in a somewhat similar discussion, stated that the Diesel type of oil engine would under certain conditions make a showing better than most engineers apparently realize. While the cost of equipment is high, the fuel economy also is high, reaching a thermal efficiency of 35% and the total cost per unit of work performed might compare favorably with coal in localities where this is expensive. In general he states:

"In stations having a daily capacity of 10,000,000 gallons and above and with coal costs around $6 per ton, the high pressure steam-driven centrifugal pump will ordinarily show the best duty per dollar of annual charges over any other isolated type of plant. In plants below this capacity, each particular installation would require thorough investigation and careful balancing of all costs, before a definite type of plant could be decided upon. It is generally recognized that, in plants of 3,000,000 to 5,000,000 gallons daily capacity, the cross-compound flywheel pumping engine will make the most favorable showing. In regard to thermal efficiency this may be true, but it would not hold in every case if the duty per dollar of annual charges were considered."

Concerning the reliability of service of an electrically-operated pumping plant, the same author stated that "with the duplicate or loop transmission lines and interconnected central stations, practically as great a reliability as in the self-contained plant will be secured."

Use of Street-Cleaning Devices

In the street-cleaning statistics collected by us a few weeks ago, and published in the October issue, nearly 200 cities gave information concerning the appliances used by them in cleaning streets and the relative areas on which the different kinds were employed. An effort is made below to summarize the information as to kinds of appliances used. There does not seem to be any practicable method of presenting summaries of the other information.

In quite a number of cities two or more kinds of appliances are used on the same area, either co-operating in the cleaning or used alternately. For instance, hand brooms are commonly used

for sweeping into piles along the gutter the dirt that is washed into the gutter by street flushers. In the same way hand brooms are used for sweeping into piles the windrows of dirt thrown up by machine brooms. In business streets the flushing machine may be used at night, while hand brooms are used by white wings during the daytime to maintain the street continuously as clean as is possible by that method. In some cities or districts hand brooms are the only method of cleaning employed; in others pick-up sweeping machines are used exclusively. To a considerable extent the practice in this regard in the different cities is indicated in the tables already referred to.

The appliance used by the greatest number of cities is the hand broom, 148 cities reporting using these, and 30 reporting not using them. Machine brooms are used by 38 cities, pick-up sweepers by 33 cities, flushing machines by 68 cities, and hand flushing by hose in 34 cities. In the matter of hose flushing, however, several cities report using this only occasionally rather than as a routine practice.

In reply to the question as to the use of machine sweepers and flushers by day or by night, 9 report machine sweeping by day, 43 by night, 2 both day and night and 7 in the early morning. Flushing is performed in the day by 19 cities, at night by 42, both day and night by 20 and in the early morning by 5. While approximately the same number use machine sweepers by night as use flushers, the number of the former used by day is less than half the latter. Probably the explanation of this is that the flusher can work more effectively than can the machine sweepers when the curbs are lined with teams, as they are apt to be in the business section during most of the day.

In the same table are given some data concerning snow removal and from this we learn that of 179 cities reporting on this question, 121 remove snow from a greater or less area of streets. The area so cleaned is usually the "business district," "principal streets," "paved streets," etc. A number of the cities remove the snow only occasionally, while others apparently make it a regular practice when the snow is at all deep. Of course, the 58 that report never removing snow include a number in the Southern States where snow seldom if ever falls.

FLUSHING STREETS

It seems to be generally believed and frequently stated that the most sanitary method of cleaning streets and the only one for thoroughly removing all dirt is that of flushing. Of about 180 cities, large and small, reporting to us the methods used by them of cleaning streets, 71 reported using flushing machines. On the other hand, however, three reported having discontinued the use of flushers, and several have greatly reduced the amount of use of them. The reasons for this were explained as follows:

"Kansas City, like a great many other cities, is short of money to carry on city business and it was economy to discontinue the use of these horse-drawn flushing machines. However, the superintendent of street cleaning says that when the department is in better financial condition he will go back to the use of these machines, as they are a great help in keeping the down-town streets clean. He also expects to ask the administration for power-drawn machines, as he believes they are of greater service than the horse-drawn vehicles, on account of our numerous street grades."

In Norristown, Penn., flushing was discontinued "for two reasons: first, the expense; second, the fact that our machine was one of the ——— flushers and produced such a powerful stream as to cause the cement in our pavements to be dislodged and the joints opened. This is also true of the joints on our Belgian block pavements, wherein tar and gravel had been used. . . . The cost of water was nil, as we are given all the water necessary for street flushing by the water company, so that was not an item of expense."

Flushing was discontinued in Chillicothe, Ohio, because "it does harm in that the continual use of same has a tendency to wash a great portion of the filler from between the bricks, leaving the same exposed, so that they are soon exposed to such an extent as to be chipped off and broken by heavy traffic. Also, there is so much water required and the dirt, at least about 80 per cent. of it, is so light that when forced to the gutter it will float down into the catch basins and will then have to be handled the second time and at a greater cost than gathering it direct with the sweeping machine, which not only cleans but also hauls the dirt with one operation. There is no question but that flushing will wash the dirt off better, but the cost of upkeep of the streets and the other unnecessary expense mentioned above should be seriously considered."

This subject was discussed at the convention last year of the International Association of Street Sanitation Officials. W. J. Galligan of Chicago said that flushing is invaluable in Chicago, one of the principal reasons being the smoke from locomotives and dust from coal and sand yards, all of which settles upon the pavement and can be thoroughly removed only by flushing. Chicago had purchased ten new street flushers last year, and intended purchasing ten each succeeding year until it had fifty. He stated that he preferred the double unit to the single unit. F. D. Furlong, of Minneapolis, said that he did not favor flushing as strongly as he used to, and that they did only half as much flushing as formerly and expected to do even less in the future. O. P. Mahoney of Joplin, Mo., said that his city had discontinued flushing altogether. B. C. Harvey of Rockford, Ill., thought it essential to flush all paved streets two or three times a week, no matter how frequently or well the street was swept.

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A. PRESCOTT FOLWELL, Editor

CONTENTS

Experience as a Basis of Imhoff Tank Design

Owing chiefly to the fact that the engineers who design sewage treatment plants very seldom operate them, and that, on the other hand, plant operators seldom design new plants, probably most of the plans for such plants that have been prepared have been based largely upon theoretical considerations rather than upon a thorough scientific analysis of the results obtained in operating similar equipment; while existing opportunities for obtaining knowledge of operating conditions, phenomena and results are too seldom taken advantage of, and therefore fail to be available as a basis for future design.

This condition gives added importance to the article in this issue by Mr. Downes, giving his analysis of the results obtained with Imhoff tanks in the plant under his charge and others, and his tentative conclusions therefrom and the application of such conclusions to the designing of tanks of this kind. Mr. Downes does not claim that these conclusions are other than tentative, and urges others who have opportunity to collect similar data to do so in order that facts may ultimately be available in sufficient number and variety to permit the deduction of general laws applicable to Imhoff tanks under all conditions.

There is every reason to hope that operating data will be secured much more abundantly in the future than they have been in the past, owing largely to state laws requiring the operation of plants by competent men, and advancement in the art of sewage treatment is bound to result therefrom.

Cleaning Filter Stone

In many and probably the majority of plants containing sprinkling filters or contact beds, any stone that may be removed from time to time because of excessive accumulation of solid matter is discarded and replaced with new stone as being less troublesome and, in some cases, less expensive than cleaning and returning. In sprinkling filters that are operating successfully it is, of course, seldom necessary to remove stone for this reason, but even with them occasions may occur when better results could be obtained by replacing the old stone with clean, fresh material than by waiting for the bed to purge itself of accumulated deposits.

The chief drawback to using old stone again is the difficulty and expense of cleaning. How this was done in a small plant by the use of appliances readily available is explained in an article in this issue. Owing to the considerable amount of labor attached to the work, and high wage rate, the expense was rather high; but, even so, it was estimated to be less than that of securing new broken stone to take the place of the old.

A Prompt Federal Report

We have had occasion several times during the years past to criticize the excessive and it seemed to us inexcusable delay in the issuing of reports of the Census Bureau and other Federal bureaus and departments. It gives us all the greater pleasure, therefore, to record unusual

promptness in the issuing of a federal report from the Government Printing Office. There reached this office on October 16th a report dated September 21st (and apparently the writing of the report was not completed until that date), which included 23 pages of text, 24 pages of tables, and 10 diagrams, four of the last-named being folded inserts. This is certainly remarkably quick work and especially so under conditions which we realize prevail in connection with the publication of Federal reports.

The report in question is that of the Federal Fuel Distributor, F. R. Wadleigh, to the President of the United States. The position of Federal Fuel Distributor was created by an act of September 22nd, 1922, and this report gives in detail the work performed by the distributor during the year of his term of office.

Another statement of this report which calls for commendation is that relative to the finances of the fuel distributor. The act establishing the organization authorized an appropriation of $250,000 for expenses and an appropriation was actually made of $150,000. Even this appropriation, however, was not spent, but the fuel distributor returned at the end of his term a balance of $46,459. It certainly is by no means customary for any federal bureau or department to limit its expenditure to 40 per cent. of the amount authorized.

Parking Automobiles

Almost every city engineer or other official having to do with traffic matters in cities of any size, whether large or small, is finding one of his most perplexing problems that of handling the automobile traffic, and especially the parking of automobiles in the business section. John Ihlder, manager of the Civic Development Department of the Chamber of Commerce of the United States, discussing this matter recently, called attention to this problem of regulating the automobile when standing still and considered possible remedies, especially those where foresight can prevent the spread of occurrence of this difficulty in sections not yet fully developed.

"In nearly all cities," said he, "large as well as small, there are considerable areas in the centers of blocks, even in downtown districts, now disused or wastefully or uneconomically used. So long as these block centers remain in private ownership, they are a constant temptation to the erection of deep, solid buildings, the lighting and ventilation of which is difficult and expensive. There is an economical depth, just as there is an economical height, for a store or office building. Where blocks or squares are so large that this economical depth is exceeded, the rear ends of the lots may well be thrown into one open space and used for parking. Incidentally, such a use, meeting a real need, would greatly lighten the task of those called upon to enforce those sections of a building code requiring light and ventilation, and it would maintain the rental value of rear offices which would no longer be shut in by the solid walls of a neighboring structure .....

"A number of methods are now being tried out, ranging all the way from storage buildings several stories in height equipped with automobile elevators, to the use of basements or cellars reached by ramps. Private initiative also has seized upon vacant lots and in some cases the backyards of business blocks and is using these temporarily for automobile parks. What private initiative has here begun indicates that municipal service can more adequately and systematically do. One rule to use as a guide here is that all such storage or parking spaces should have their entrances and exits—and they should have separate exit and entrance—on side streets or minor streets where the constant crossing of sidewalks by automobiles will least interfere with pedestrians."

Mr. Ihlder, however, does not believe that the use of all these methods to the utmost practicable extent will meet the demand.

The difficulty occurs not only in the business district, but also in the residential district. Here the parking is more likely to occur at night, and night parking in such districts is objected to with reason.

The truck presents an additional problem because of its size. If parked parallel to the curb, it takes up a large amount of space and is placed inconveniently for loading. If parked at an angle, it projects too far into the roadway and often on to the sidewalk as well.

Apparently Mr. Ihlder has no solution to recommend for existing business sections. He concludes, however, that it makes imperative the city planning and street designing of new sections and new cities so as to prevent to a very large extent the congestion which is now found in all of our larger cities.

Completing Contracts on Time

The Alabama State Highway Department on October 22 made public the ruling "that all contractors be and they are hereby notified that if contracts taken by them are not finished by them within the time stated by such contractors in their proposals, that all expense of all kinds incurred by the State growing out of these unfinished projects shall be paid by said contractors. This rule to be enforced on and after December 1, 1923."

Just what expenses the department had in mind we do not know, but the statement would at least include the salaries of engineers and inspectors employed in supervision of the contract. Possibly other expenses may be included, such as the upkeep of detours. It is not stated whether the clauses of the contract providing for extension of time would act to relieve the contractors of the payments of these expense. Where the delay was in no way avoidable by him, it would not seem just to charge him with them, especially in view of the fact that this delay has probably also burdened him with expenses which it was not possible for him to avoid and which he had no reason to anticipate.

Where the contractor is responsible for the delay, however, we believe that it is perfectly proper to charge these expenses against him and we believe that the courts have upheld these as legal. The writer made a practice of including a similar clause in contracts prepared by him for public works twenty years ago.

Notes on the Proper Placing of the Slots in Imhoff Tanks

By John R. Downes

Study of unprecedentedly complete data shows that a great improvement in operation may result from a small change in the distance between the slot and the hopper, effective storage space increasing much more rapidly than such distance.

A recent conference with Dr. Imhoff has brought home to me a point of view with regard to the proper placing of the slots of the Imhoff tank which, so far as available literature would indicate, seems very largely to have escaped the notice of most engineers. Dr. Imhoff was very emphatic in the statement that the mere provision of a given number of feet capacity in the digestion chamber means absolutely nothing unless such capacity is obtained by the proper proportioning of the three dimensions.

On thinking this over in connection with my own experience and with data made available by the N. J. Sewage Experiment Station, I determined to attempt to produce a graphic presentation of the facts which would throw more light on proper proportioning of the three dimensions.

The following data were at hand:

(1) A concrete example in which Dr. Imhoff had indicated a modification of an existing tank to secure additional distance between the hopper and the slot and at the same time to secure better distribution of the sludge (freshly deposited solids). See Plate II.

(2) Operating data on the tanks in question showing that digestion was very poor at first but had been greatly improved later by improving the solids distribution through manipulation in operation.

(3) Published data from various sources indicating that the best digesting tanks evolve gases in approximately the following proportions:

CO_2—10%; CH_4—85%; N—5% or less.

(4) Data furnished the Research Commission of the N. J. Sewage Works Association by the New Jersey Sewage Experiment Station, showing the proportion of different gases evolved at different stages in the digestion of sewage solids. (While the latter was confined to two tests of the same sample under different conditions, the results check with other experiences with complete and incomplete digestion.) See Plate I.

(5) Volume of solids deposited (calculated from cone glass readings), and volume of sludge accumulated in tanks over a period of years.

(6) Length of time required to digest solids to a 90%-95% sludge which can be handled without nuisance and with fair economy. (The best sludge obtainable in the tanks in question). This length of time was observed by carefully drawing all the sludge of this definite degree of digestion from all the hoppers of a tank: then putting the tank into operation for definite periods of time, repeating the drawings and making measurements. These measurements check with fair accuracy the quantity of "ripe" sludge drawn from the tanks over a period of years.

Weighing all the evidence in hand, it would appear as a logical proposition to state that: The slot of a two-story tank should be placed with due consideration of the progress of digestion which will have been attained at the time when the fresh solids (without shrinkage) would have accumulated to a depth equal to the distance between the hopper and the slot, and that the horizontal dimensions of the tank should be such that the solids shall be evenly distributed in so far as possible.

For instance, in the case cited to me by Dr. Imhoff, the original design so placed the slot that, in cold weather, digestion could not possibly have begun at the time that the accumulating solids reached the slots. In warm weather the digestion process would have arrived at the shifting point between CO_2 digestion and CH_4 digestion at the time the solids reached the slot. See Plate I.

Of course, except when putting a new plant into operation, we do not start with all fresh solids, but a little consideration will indicate that a new digestion curve (Plate IV — digestion of unit volume of solids in percentage of original volume) starts on its course each day of operation to terminate 30 days later. Meanwhile 30 other unit volumes have started to digest and a volume equal to 70% of 30 days fresh deposits is always on hand, in the transition stage.

The fact is that the tanks in question acted exactly as if there had been no contraction or digestion shrinkage, probably because what little progress in digestion had been made at the time when the solids reached the slot had simply evolved gases which buoyed up and distended the mass of solids.

In this case, while the total volume of space between slot and hopper provides for 57 days storage of the settling solids as calculated from cone glass readings, the distribution of the solids was such that they deposited to a depth of 4 inches per day (average) and to considerably greater depth at the inlet end. The average of 4 inches per day would mean that the accumulating solids would reach the slot in 18 days.

At a later date it was established that the digestion period in summer weather was 30 days.

By altering the operating program to improve the distribution of solids, the effect was gained of raising the slot to a point where the oldest solids had

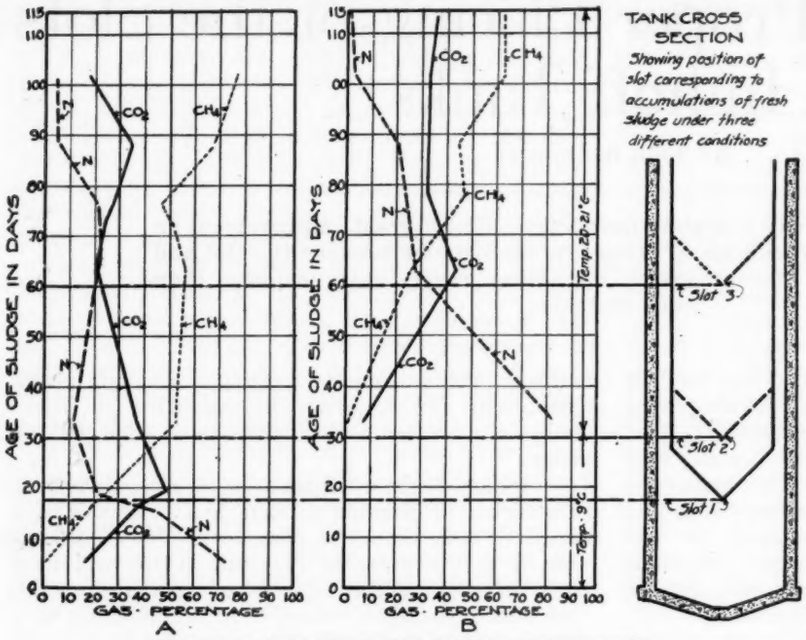


PLATE I—PROGRESS OF SLUDGE DIGESTION.

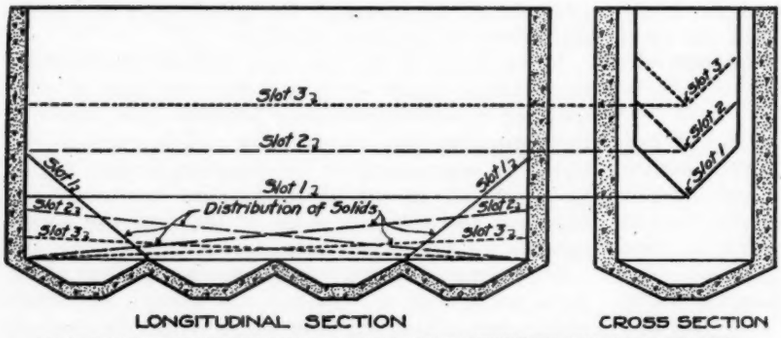
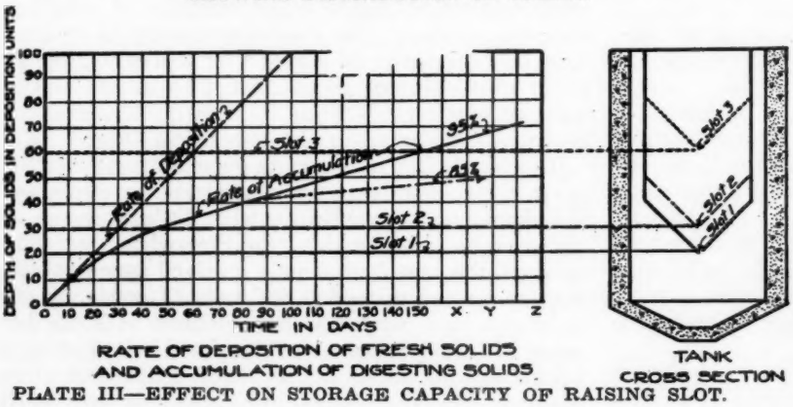


PLATE II—LONGITUDINAL SECTION THROUGH IMHOFF TANK, SHOWING DISTRIBUTION OF SOLIDS.



RATE OF DEPOSITION OF FRESH SOLIDS AND ACCUMULATION OF DIGESTING SOLIDS.

PLATE III—EFFECT ON STORAGE CAPACITY OF RAISING SLOT.

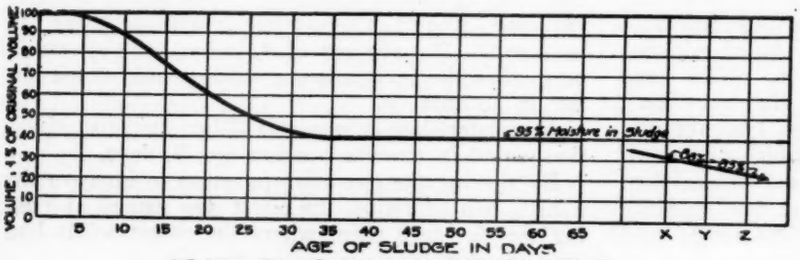


PLATE IV—SLUDGE DIGESTION CURVE.

PLATE I:

Showing progress of sludge digestion as indicated by the relative proportions of the gases evolved, CH_4, CO_2, N_2. Sample of solids collected in settling compartment of an Imhoff tank so as to represent all grades of solids proportionally; divided into two one-liter portions, and:

A—incubated at 20° to 21° C. throughout.

B—incubated at 9° to 20° C. for 31 days, during which digestion was prevented and after which it was retarded, even after the temperature had been raised to 20° C.

At the right is indicated the relative position of the slot of an Imhoff tank with reference to the progress of digestion under three different conditions. This is shown in number of days' accumulation of fresh solids required to reach the slot.

Slot 1—Position of slot as constructed and operated according to original program. Distribution of solids as indicated by solid line on longitudinal section through tank in Plate II.

Slot 2—Position of slot when a better distribution of solids had been attained through manipulation in tank operation using 50% of the tanks at one time. (For distribution of solids, see long dash line in Plate II.)

Slot 3—Position of slot in tanks altered in accordance with the suggestion of Dr. Imhoff, providing most effective distribution of solids and the use of all tanks constantly. For distribution of solids, see short dash line on longitudinal section through tank in Plate III.)

PLATE II:

Longitudinal section through Imhoff tan'-, showing distribution of solids.

Slot 1—Constructed and operated as designed.

Slot 2—Constructed as designed. Use of half the tanks secures effect of slot 3.

Slot 3—Reconstructed and all tanks in use; makes 100% of capacity available through better distribution.

PLATE III:

Shows effect on actual storage capacity of digestion chamber of so proportioning the three dimensions that the accumulated solids, without digestion, reach the slot elevation only after a period of time equal to that required to complete the digestion of the initial solids.

"Deposition unit" equals depth of fresh solids deposited daily, i. e., number of cubic feet of solids divided by square feet in area covered.

PLATE IV:

Curve indicating shrinkage of unit volume of fresh solids in digestion compartment of Imhoff tank. The summation of volumes of daily accumulations of solids, each decreasing in volume according to age as shown in this curve, gives the "Accumulation curve" on Plate III.

completed the 30-day digestion period before the surface of the uncontracted solids reached the slot elevation. The improvement in operating results was very marked. See Plate III.

It is very interesting to note that this 30-day period corresponds, on the one hand, to the observed time of digestion under operating conditions, and on the other to the attainment of maximum production of CH_4 (in proportion to the other gases). See Plate I. The effect was that of moving the slot from the point where the production of CO_2 is reaching its maximum and is equal to the N production, to a point where CO_2 and N production have receded sharply and CH_4 and CO_2 are turning to an approximately parallel course.

From the point where the 30-day digestion period is past, we may look for a real reduction in volume of solids. The first day's quota of solids has now been reduced to 40% of the original volume and successive portions to points between 40% and 100% of the original. Possibly a straight line between 100 at the end of the fifth day and 40 at the end of the 30th day, following in a general way the line for percentage of CH_4, will represent the progress of digestion. Accepting the above proposition for trial, we find that we have 70% of the month's accumulation of solids still on hand in various stages of decomposition at the end of the month.

Now assume the change suggested by Dr. Imhoff to have been made. This, in effect, raises the slot up to the level which would be reached by 60 days deposits of uncontracted solids. At the end of 60 days the first 30 days accumulation of solids has all been reduced to 40% of its original volume and the second 30 days accumulation to 70% of the original volume, so that the actual elevation of the sludge is at a point equal to but 33 days accumulation of uncontracted solids, and one-half of the original deposits are fit to be drawn as sludge. This latter portion now equals 36% of the accumulation in the tank.

It will be noted that nitrogen production in experimental digestion falls rather sharply to a minimum of 5% or less about the 90th day. This possibly means that the true end of digestion is approaching, as compared with the point on the 30th day where digestion had progressed sufficiently so that sludge could be drawn and handled with fair economy and without nuisance.

If, now, instead of drawing the ripe sludge at the 60th day we take advantage of the shrinkage of 60 days deposits to the volume of 33 days deposits, to continue digestion toward a point where the N fades out and digestion is assumed to be nearing completion, we have but to follow the accumulation line in Plate III to find that we may continue on for 150 days.

Our calculations have been based on our actual experience with a "ripe" sludge of 90% to 95% moisture content. Imhoff pointed out that in satisfactory tanks this moisture content would be reduced to, say, 85% resulting in a further reduction in volume of space occupied. However, this fact does not permit of restricting the digestion space on the basis of 85% sludge, for the simple reason that such sludge is to be obtained only after a comparatively long lapse of time. At present we have no definite information concerning the length of this period of time, but we do know that it is more than 60 days, probably more than 90. In plate IV it is indicated that a further reduction in volume will occur in an unknown period of time X, Y or Z. The course of the accumulation curve in plate III would be altered in the general direction of the dot and dash line terminating in the arrow.

Another effect of providing ample storage space as outlined will be that more sludge (beyond the 30-day digestion age but still actively evolving gases) will be stored per unit of surface area, thus concentrating gas evolution, so that large bubbles of gas capable of causing a stiring action will be produced as compared with the minute bubbles which merely serve to hold all the solids in a state of quiet suspension. Any mechanical agitation releases the solids from the minute gas bubbles, the solids separating by gravity. Such mechanical agitation would be produced by rapid ebullition of gas in large bubbles such as are obtained in the very successful plants at Rochester, N. Y. The alteration suggested increases depth of such sludge from zero to 30 deposition units.

There will occur to the mind many ramifications of the problem, the discussion of which would make this article endless. Enough has been shown to indicate the importance of ample distance between slot and hopper. To give a practical illustration of the importance of this feature we may refer to the case cited by Dr. Imhoff. In this case in the original design, 6 feet was allowed between hopper and slot and this space was filled in 18 days. By adding only 4 feet to this height so as to raise the slot above what we may call the transition zone, we change the effective storage space to 150 days, as shown in Plate III (considering only the known facts with regard to 90%-95% moisture sludge).

This is, perhaps, the first time that so complete a set of data has been available for making these calculations. I have sought not to burden the text with statistics, relying rather on the graphic presentation of the facts to establish the reasonableness of the proposition and to make clear what a great difference in operation a seemingly small difference in distance between slot and hopper may make.

The "reasonableness" of the proposition is spoken of because of the realization of the fact that there is no proof other than by trying it on in the case of various tanks. This is not a one-man job and these notes are therefore made public for the purpose of promoting discussion, with full confidence that their consideration can not possibly affect design other than in the right direction.

Joint Water Supply for North Jersey

Eight municipalities of the northern part of New Jersey have asked recently to be permitted to join Newark in the development and use of the Wauague supply, the dam and tunnel for which are under construction. This will consume the entire estimated yield of 100,000,000 gallons a day.

The Sludge Problem*

What has been done recently toward solving the sewage sludge problem, especially at Milwaukee, Chicago, Baltimore, Rochester and Houston

MILWAUKEE SEWERAGE COMMISSION

Mr. T. Chalkley Hatton gives the following notes on the Milwaukee work:

The Milwaukee Sewerage Commission appointed a Fellow to the Agricultural College of the University of Wisconsin who has devoted his entire time to the use of sludge in agriculture. Intensive studies have been made of the values of activated sludge in comparison with commercial fertilizers of different mixtures. Plantings were made of corn, soy beans, Sudan grass, tobacco and other crops at the experimental farms of the University of Wisconsin, at Marshfield, Hancock, Codington, Madison and Wauwatosa. To determine the value for grass in golf greens, tests are being made at the Blue Mound, Ozaukee, Lynx and Tripoli Golf Clubs, and the Milwaukee Country Club and the Pine Bluff Country Club. A large number of pot cultures have also been made at the greenhouses of the University of Wisconsin.

The National Fertilizer Association has also been advised of the possible value of activated sludge. Samples have been sent various fertilizer distributors for investigation. The cooperation of the Executive Committee of the Association has been assured in handling and marketing the prepared sludge should it prove as satisfactory as appearances indicate.

SANITARY DISTRICT OF CHICAGO

The Sanitary District of Chicago has interested a number of agricultural experiment stations in growing tests. Work is under way on cotton in Mississippi, and on garden plants at the University of Illinois. In the Chicago territory sludge has been distributed to peony and rose growers, truck farmers, cabbage growers and to various individuals. The Lincoln Park, West Side and South Park organizations are trying sludge on lawns and grass plots.

The District has operated a test plot during the growing season, planting corn, beets and beans, with various combinations of fertilizer. Some 45 plots, each 1,100 sq. ft. in area were planted. The land, while formerly used for truck gardening had lain idle for over four years. The results in general have been encouraging. A record of weights is being kept, as the vegetables are picked, which will furnish a criterion of the real relative production.

In addition, the District has used sludge in seeding grass, in comparison with sheep manure.

The best price obtained during the year on the sale of carload lots was $9.00 per ton f. o. b. cars for sludge, dried and bagged.

BALTIMORE

Mr. Milton J. Ruark, Division Engineer of Sewers, gives the following notes of interest with reference to the sludge handling problem of Baltimore: During the year 1922, the total production of sludge was about 5,400 tons on a dry basis. This is the greatest rate of production in any year since 1918, when the output was somewhat greater. During the year 1922, about 5,500 tons on a dry basis was handled, a portion of this being heat dried sludge from the drying plant and the remainder air dried sludge taken by local farmers. For more than a year no charge has been made for air dried sludge. This season farmers have taken the sludge as often as it is produced by the sand beds, so that the drying plant has not been operated for several months.

At the present time, no income is being realized from the sale of sludge. The city has provided means to load the farmers' trucks from a trestle by dump cars direct from the sand beds, or by a derrick from the storage pile. As a rule the farmer arranges to handle sludge only when the city is operating one of the loading devices. Occasionally a farmer loads his own truck. The sludge is all used within a radius of about 4 miles, whenever possible, the farmers hauling it directly to the field, where it is spread and plowed under. Sometimes it is placed in piles or composted with manure for spreading on the fields at a later date. The farming community served is almost entirely composed of truck farmers. The sludge is therefore used to a large extent for such plants as cabbage, spinach, potatoes, stringbeans and tomatoes. It is used to some extent on corn, and to a very limited extent on grass. The amount of horse and cow manure available has decreased markedly in the last few years with the result that its cost has reached a point where farmers are seeking other materials for fertilizer. While it is evident that the farmers in the vicinity of the Baltimore plant believe the sludge is worth the handling, the city officials have desired to satisfy themselves of the real value of the sludge in agriculture. In cooperation with the Agriculture Experiment Station of Baltimore, a series of experiments have been outlined to extend over some 4 or 5 years. Nine acres have been laid out in 6 sections of 1½ acres each, each section being divided into 6 plots of ¼ acre each. The whole of each section has been treated with one of the following fertilizers: Liquid digested sludge, air dried sand bed sludge, commercial fertilizer, commercial fertilizer and dry sludge and manure. As a control, one plot has been given no treatment. One-half of each section then was treated with lime in a manner to cover half of each plot. In one plot of each section will then be planted some crop, and likewise with each of the other plots, so that in any year some crop will be growing on ground treated with all of the six fertilizers, both with and without lime. Rotation of crops will probably be introduced, but the ground will receive the same fertilizer year after year. A special experiment with alum treated sludge will also be started on other ground.

At the date of September 15, the farm was already growing late potatoes, beans and fall cabbage. It is proposed to plant spinach and grass seed in the fall and next spring to add another crop, probably tomatoes, making a total of six different crops.

*Report, made on October 10th, of the Committee on Sludge of the American Public Health Association, consisting of Langdon Pearse, chairman; T. Chalkley Hatton, C H. Hurd, Earle B. Phelps and W. L. Stevenson.

The preparation of air dried sludge for the year 1922 cost $.666 per ton.

ROCHESTER

Mr. John F. Skinner reports that at the Irondequoit plant of the city of Rochester, N. Y., about 10,600 cubic yards were prepared for market in 1922 by air drying. This sludge was sold at an average price of $0.75 per load of 2 cubic yards to farmers, delivery being made by a tipple to the teams and auto trucks. When shoveled from storage only $0.50 was received by the city. The sludge is largely used in the top dressings of the orchards for a distance of 7 miles around the plant.

HOUSTON

From Houston, Mr. J. C. McVea reports that during the calendar year 1922, 4 cars of sludge were sold. The buyers preferred sludge which had not been pulverized. Five tons were delivered to local truck growers and others for use near Houston. The results obtained by various gardeners and by the Houston City Park Superintendent on the municipal golf course and in the parks have been very gratifying. Growing experiments were made on a small scale with turnips, tomatoes, lettuce and radishes, in which the value of the sludge as a fertilizer was demonstrated. In particular, the turnips were vastly improved, the ones fertilized with sludge being the only ones edible, being sound and sweet, the others being dry and fibrous. The results on the turnips are given by the following table:

Percentage Increase Over Unfertilized Turnips

No.	Weight in Ounces			Per Cent Increase			How Fertilized
	Total	Roots	Tops	Total	Roots	Tops	
1	11	3	8	0	0	0	Not fertilized
2	18	7	11	64	133	38	Blood
3	41	14	27	273	367	237	Nitrate Soda
4	63	28	35	473	832	338	Activated Sludge
5	59	31	28	426	932	250	Activated Sludge and Phosphoric Acid

Production Data and Analysis of Sludge Reported for 1922

City	Baltimore	Rochester	Chicago	Houston
Plant	Hydrolytic-	Imhoff	Activated	Activated
Production in 1922, net tons dry weight	5,421	6440	400*	70†
Air dried cu. yd.		10600		
Analysis on dry basis		Per cent		
Nitrogen—				
Average	2.45	2.00	5.0	4.6
Maximum		2.17	5.6	
Minimum		1.95	4.3	
Phosphoric Acid	0.52	0.8	2 to 4	1.9

*Approximate amount on 12 months, 1922-3
†Produced for experimental use and sold as fertilizer. Estimated production would be 1,720 tons, if prepared.

PREPARATION OF SLUDGE

In the preparation of the sludge, development of methods and apparatus is still progressing with very encouraging results.

At Milwaukee, the tests have been concluded on sludge handling, with the conclusion that provision should be made for the use of acid and heat with the Oliver filter.

At the Des Plaines River Sewage Treatment Plant of the Sanitary District of Chicago dewatering has proceeded using alum, or acid, with and without heat. At first only a Worthington bag plate press and a Simplex plate press were available. In August tests were begun on a novel hydraulically operated bag press, designed by Berrigan, with direct squeeze, which has the advantage of taking care of any desired thickness from ¼-inch upwards. The press cake (in moisture content fom 73 to 83% moisture) is dried in a rotary direct-indirect dryer. A pulverizer is required to crush the balls which occur, though not in large number.

At the Calumet Sewage Treatment Works of the Sanitary District, dewatering has proceeded using alum or acid on the Oliver filter installed. This filter is the largest size built, the drum being 11 ft. 6 in. diameter with a face 14 ft. wide. Space has been left in the house for a Basco-ter-Meer centrifugal. A dryer similar to the one at the Des Plaines River Sewage Treatment Works operates on the sludge cake intermittently.

At the testing station operated jointly by the Sanitary District and the Corn Products Refining Company at Argo, tests have been run on plate filters and a single wheel American rotary filter. Alum has proved more successful as a coagulent than acid.

At Houston, the cost of preparing the sludge has not yet developed to a point where definite costs can be given. Several methods have been tried. At present the use of sulphur dioxide gas is being tried to prepare the sludge for pressing. There has been no complaint of odor from sludge handling or the preparation of the sludge.

The nitrogen recovery in activated sludge at the various points of operation is as follows:

Recovery of Nitrogen and Phosphoric Acid from Activated Sludge

Nitrogen as N; Phosphoric Acid as P_2O_5; Per cent dry basis.

Location	N	P_2O_5
Sanitary District of Chicago—		
Argo	7 to 8	6 to 7
Tannery	3.0	
Parkingtown	4.2	2.7
Des Plaines R. S. T. W.	4.5 to 5.5	2 to 4
Calumet S. T. W.	4.2 to 4.4	
Houston	4.6	1.9
Milwaukee	6.0	2.3

By the alkaline permanganate method the total available ammonia in the Milwaukee sludge is 4.61 per cent, 63 per cent of the total ammonia.

Paving Brick Production

The report by the National Paving Brick Manufacturers' Association of the production and shipments of paving brick for the month of August, compiled from figures submitted by companies representing 69% of the capacity of the industry, showed orders received during the month for about 13½ million plain wire-cut brick 3x4x8½; 3¼ million plain wire-cut 3½x4x8½; 5½ million repressed lug 4x3½x8½; ⅛ million wire-cut-lug 3x3½x8½; 1½ wire-cut-lug 4x3½x8½; and no wire-cut-lug 3½ x3½x8½. The shipments during the month were approximately 14½ million plain wire-cut 3x4x8½; 6 million plain wire-cut 3½x4x8½; 9 million repressed lug 4x3½x8½; ¾ million wire-cut-lug 3x 3½x8½; and 3½ million wire-cut-lug 4x3½x8½.

The above are all recognized standard sizes and varieties. In addition, there were shipped during the month 2½ million No. 1 brick of varieties no longer recognized as standard, while orders were

received for one million of such special brick. The orders, which apparently would be the best indication of present practice, showed choice of about 25 times as many of the standard varieties as of those not now recognized as standard. As the unfilled orders showed a ratio of only about 10:1, the indication is that consumers are rapidly accepting the new standards and abandoning those which were eliminated by the agreements made a few months ago.

The figures were arranged by the association by states and also as to use on city streets or country highways. The latter classification showed that about 26 million of those shipped were intended for city streets and only 7.4 million for country highways. Shipments were made during August for country highways in Illinois, Indiana, Kentucky, North Carolina, Ohio, Pennsylvania and West Virginia. In the majority of these states the number of bricks shipped for city streets greatly exceeded those shipped for country highways, the notable exceptions being North Carolina, with 168,000 for country highways and 191,000 for city streets, and Ohio with 5,784,000 for country highways and 5,781,000 for city streets. Shipments for city streets were made to 25 states and Canada.

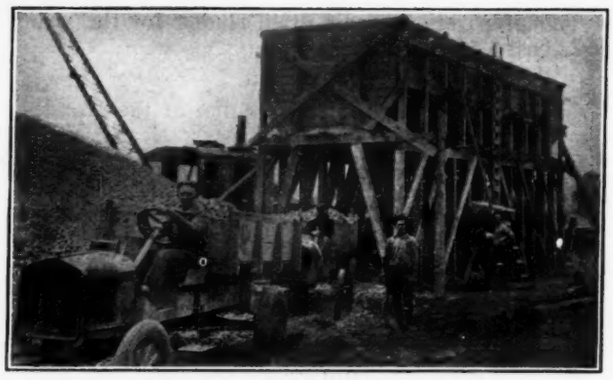
Good Work on Dixie Highway

Methods and plant employed by contractor in building 12½ miles of this road in Kentucky, of rock asphalt on a concrete basis.

The Dixie Highway, extending from the Great Lakes to the Gulf of Mexico, is unlike most national highways in that it does not follow a single line. For a portion of its length it is split into two approximately parallel lines, usually designated the Eastern Dixie and the Western Dixie.

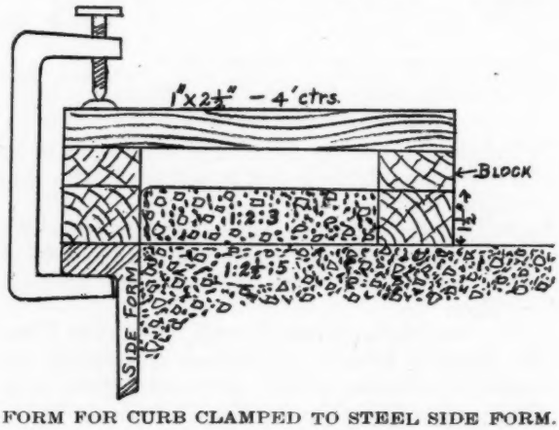
Both branches of this highway traverse the State of Kentucky, one entering the state at Covington, and the other at Louisville. The latter branch traverses level or rolling country in its course across the central part of the state. About half of the Eastern Dixie is through similar topography but when it leaves the Bluegrass section of the state, it enters the coal and timber fields and runs through the Kentucky mountains to the Tennessee line. Both sections of the Dixie Highway are being extensively improved by the State Highway Department.

One of the most interesting portions of the Eastern Dixie is the contract being executed by Metzel, O'Hearn, Vastine and Lewin between Barbourville and Pineville. This is a 12½ mile contract which is being paved with Kentucky rock asphalt on concrete base with integral curbs. The base is 6 inches thick, of 1-2½-5 concrete and the surface is 1½ inches thick. The curbs are 6 inches wide, finishing flush with the asphalt surface, and the mixture is 1-2-3. The road is 16 feet wide on tangents, increased to 18 or 20 feet on curves. The grading was done last year under another contract.



BINS FOR AGGREGATE, AND STOCK PILE.

The contractors are building the entire 12½ miles from two set-ups. The first was at the northern end of the contract; later the plant was moved to a point about 2½ miles from the southern end. Additional set-ups were not practicable, largely because intermediate points were not accessible to the railroad. The unloading was done with an Erie crane on caterpillars equipped with ¾-yard Blaw clam-shell. The cars were spotted at the crane by a Fordson tractor, following which the aggregate was removed to either the bins or the stock pile. To facilitate unloading hopper cars, two concrete pits were constructed at the side of the railroad track to receive the aggregate, from which it was taken by the clam shell. This equipment handled from 8 to 10 cars of aggregate per day. The bins were equipped with a pair of Blaw-Knox batchers, one delivering stone or gravel, and the other sand. The cement was unloaded directly from railroad cars to the trucks, any surplus being placed in the warehouse. Two or three cars of cement were used each day. Dry batches were drawn to the mixer by a fleet of Ford trucks varying from 8 to 17, depending on the length of haul. After receiving its coarse and fine aggregate, the truck was driven past the cement platform where the cement was dumped by hand upon the aggregate. Arriving

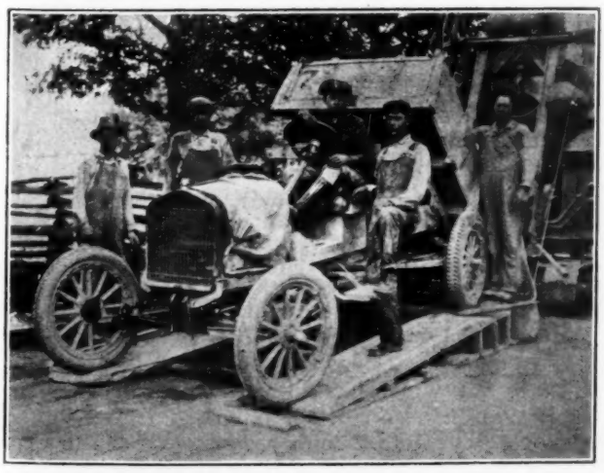


FORM FOR CURB CLAMPED TO STEEL SIDE FORM.

CONCRETE MIXER, AND INCLINED RUNWAY FOR RECEIVING TRUCK.

at the mixer, the truck was run onto a turntable, turned around and backed to the mixer and the batches dumped into the hopper from an inclined portable runway. The mixed concrete was discharged on the subgrade between Blaw-Knox steel forms and was compacted and shaped by hand and a wooden templet. The mixer was a 21 E Smith, gas-driven, mounted on caterpillars.

The method of building the integral curbs seems to be unique. A portable box was carried along each side of the road and into this a batch of 1-2½-5 concrete was dumped as needed. Additional cement and sand to bring it up to a 1-2-3 mix was added by hand for use in constructing the curb. The form for the curb was made of light wood built in 12-foot sections, which produced a form easily handled and bent to curved alignment where necessary. One side of this form rested on the steel form and the other side on the concrete base, the whole being clamped to the steel form. The curb concrete was placed in this wooden form by hand and finished with trowels. No difficulty or delay whatever was experienced in forming the curbs, which was contrary to the experience of many contractors.



TRUCK DUMPING FROM INCLINED RUNWAY

When the concrete base had partially set and before the curb forms were removed, the surface of the base was scored in three directions by means of a hand-drawn corrugated roller, the corrugations being about 2 inches apart and extending ½ inch into the concrete. By pulling the roller across the pavement in three directions a very uniform and positive scoring of the base was secured, which was designed to prevent crawling of the asphalt.

The rock asphalt was unloaded by means of the Erie crane into trucks and was placed on the base in the customary manner by the use of hand labor and rollers.

Water for the entire project was supplied by a Barnes triplex road pump mounted on wheels and operated by a 4-cylinder gasoline automobile engine, driving the pump through a clutch and gears. The pressure at the pump was 275 lbs., which gave a pressure of 85 lbs. at the mixer through three miles of 2-inch pipe.

This work gives an impression of being unusually well organized and equipped. Every piece of equipment seems perfectly fitted for its place and well balanced with the rest of the outfit and the contractors report that the equipment is even more satisfactory than they had anticipated.

The progress made on this work is very commendable when it is understood that only one outfit is employed on the job. Laying concrete began April 16 of the present year and 10 miles had been completed on September 4, the last five miles having been laid in 35 days or 360 hours of actual operation. The maximum day's run of concrete was 1,335 lin. ft. in 12½ hours, while the maximum in laying asphalt was 1,040 ft. and the average about 850 ft. The contractors anticipate completing the last 2½ miles of base and surface in 30 days.

The work is being done under the personal supervision of the four members of the firm, with J. Steve Watkins as District Engineer for the State; G. L. Logan, Assistant District Engineer, and Jas. Gard, Resident Engineer.

Street Widening in Akron

Akron, Ohio, on October 15, completed its most important street widening improvement, that of West Market Street. One of the interesting features of this improvement was that, while a bond isue of $625,000 was authorized for the work and $450,000 of bonds were sold, the actual cost was only $433,000.

Director of Service W. F. Peters states that the cost was reduced chiefly by following a new procedure in condemning and appropriating property. A number of large buildings projected beyond the street as widened and the city purchased not only the buildings but also land in the rear of them and contracted for moving the buildings back onto this land, thus salvaging a considerable percentage of the value of the buildings which it at first was thought would have to be destroyed or largely rebuilt with new fronts and shallower depths.

Recent Legal Decisions

DATE OF FILING CLAIMS ON MUNICIPAL CONTRACTS IN MASSACHUSETTS

The Massachusetts Supreme Court holds, Hurley v. City of Boston, 138 N. E. 838, that under Mass. St. 1909, c. 514, §22, requiring statements of claims of subcontractors on municipal contracts to be filed within 60 days after completion of the work, a contract providing that the date of completion shall be decided by the architect binds the subcontractors by his decision if he acts in good faith and uses his best judgment, but where he makes no examination or inspection of electrical, heating, ventilating and plumbing work, and relies on the judgment of others, without exercising his own, his decision is not binding.

PROPERTY OWNERS ALLOWING IMPROVEMENT TO PROCEED CANNOT OBJECT TO ASSESSMENT

The New Jersey Supreme Court holds, Graham v. Ocean City, 119 Atl. 772, that where a city has been permitted to go on and incur the expense of an improvement (in this case the construction of a bulkhead) without objection to the validity of the ordinance, and then assesses the benefits, it is too late for property owners to object to the assessment on the ground of the invalidity of the original ordinance.

EXCAVATION FOR CELLARS IS WORK ON ERECTION OF BUILDING UNDER BUILDING PERMIT

Where an ordinance requires the submission of a detailed description of the proposed work to the building commissioner before the erection, construction or alteration of any building, and provides that work shall not be commenced until a permit is issued, the Massachusetts Supreme Court holds, Commonwealth v. Atlas, 138 N. E. 243, that actual excavation for cellars of proposed buildings constituted work on the erection and construction of a building within the ordinance. The making of foundations is as essential for a building as the fabrication of its walls.

CONFORMITY OF ENGINEER'S ESTIMATE TO ORDINANCE

The Illinois Supreme Court holds, Ownby v. City of Mattoon, 306 Ill. 552, 138 N. E. 110, that no fatal variance exists between the engineer's estimate for a paving improvement and the ordinance therefor because the estimate makes no provision for a top dressing, while the ordinance so provides, where the estimate provides for the amount of yardage of brick paving, the cushion therefor, the base of the paving, and the filler to be used in the cracks to bind the brick together and make a uniform surface; the Illinois courts holding it unnecessary that the estimate of cost should contain a complete inventory of every article that is to enter into the construction of the improvement (Village of Donovan v. Donovan, 236 Ill. 636, 86 N. E. 575).

Nor is there a variance because the estimate provides for 9,000 feet of curb 5 inches in width, etc., while the ordinance specifies the curb shall be 5 inches wide at the top and 6 inches wide at the bottom. The curb is still a 5-inch curb, the ordinance merely describing what it shall be where it joins the gutter-flag.

ACQUITTAL OF CODEFENDANT OF NEGLIGENCE BAR TO RECOVERY AGAINST CITY WHOSE LIABILITY IS DERIVATIVE

The Supreme Court of Appeals of Virginia holds, Sawyer v. City of Norfolk, 116 S. E. 245, that where a pedestrian was thrown down and injured by the violent opening of a restaurant screen door extending 23 inches over the sidewalk, and brought suit against both restaurant and city for negligence, an acquittal of the restaurant was a bar to recovery against the city, its liability being derivative and dependent upon the negligence of the restaurant. The same question has been decided in the same way in Indiana, New York, New Hampshire, Rhode Island and Illinois.

PLAINTIFF IN ACTION FOR EXCAVATION ACCIDENT MUST SHOW THAT NEGLIGENCE CAUSED INJURY

In an action against a paving contractor by a husband for injuries to his wife caused by her falling while walking over an excavation, the Missouri Court of Appeals holds, Waldmann v. Skrainka Const. Co., 249 S. W. 698, that assuming that the defendant company was guilty of negligence by violation of the ordinance of the city of St. Louis requiring excavation in or adjoining an alley to be fenced with a substantial fence not less than three feet high, it would still be necessary to prove the negligence alleged, that defendant cut the south edge of the sidewalk so as to leave the edge rough and jagged, and dangerous to pedestrians, and also to show a causal connection between the accident and the negligence charged to make a case for the jury.

CITY HELD NOT LIABLE FOR ILLNESS CAUSED BY INSANITARY CONDITION OF DEFECTIVE SEWER

The North Carolina Supreme Court holds, Saudlin v. City of Wilmington, 116 S. E. 733, that where a city maintained a nuisance consisting of overflow of sewage from a defectively constructed sewer on the plaintiff's premises, and she sues for damages for her illness caused thereby, and not for any injury done to the property or to her interest, if any, therein, she is not entitled to damages for personal discomfort caused by the alleged nuisance.

CITY BOARD CANNOT, WITHOUT AUTHORITY, PURCHASE INTANGIBLE ASSETS OF COMPETING UTILITY

The Georgia Supreme Court holds, Board of Lights and Waterworks of Marietta v. Miller, 116 S. E. 835, that a city board of lights and waterworks, which has no authority to purchase the intangible assets of a competing electric light and power business, could not expend the city's money either on express or implied contract to effect such unauthorized objects and purposes.